SCIENCE

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*THE DEVELOPMENT OF PHOTOGRAPHY IN ASTRONOMY (I.).**

THE American Association for the Advancement of Science has now completed an existence of half a century. It has become one of the leading scientific institutions of this country. Since its organization fifty years ago the world has advanced with wonderful rapidity in all directions, and especially in the various fields of science. It is hardly too much to say that the scientific progress in the last half century far exceeds all that was done in the preceding thousand years. The life of this Association practically covers the development and comparative perfection of many of the sciences. This is especially true of the wonderful art of photography. At the beginning of the work of this Association the great discovery of making pictures by the natural light of the sun had just been made, and while it aroused a widespread interest all over the world at that time there were very few who dreamed of the great future value of photography in the arts and sciences. One of those who saw something of the future of Daguerre's discovery was the celebrated Scottish astronomer Dr. Dick, whose works on popular astronomy are still useful and delightful reading. In his 'Practical Astronomer,' published in 1845, he said:

*Address of the Vice-President before Section A—Mathematics and Astronomy—of the American Association for the Advancement of Science, August 22, 1898.

"It is not improbable, likewise, that this art (still in its infancy) when it approximates to perfection, may enable us to take representations of the sublime objects of the heavens. The sun affords sufficient light for this purpose; and there appears no insurmountable obstacle in taking, in this way, a highly magnified picture of that luminary which shall be capable of being again magnified by a powerful microscope. It is by no means improbable, from experiments that have hitherto been made, that one may obtain an accurate delineation of the lunar world from the moon herself. The plated discs prepared by Daguerre receive impressions from the action of the lunar rays to such an extent as permits the hope that photographic charts of the moon may soon be obtained; and, if so, they will excel in accuracy all the delineations of this orb that have hitherto been obtained; and, if they should bear a microscopic power, objects may be perceived on the lunar surface which have hitherto been invisible. Nor is it impossible that the planets Venus, Mars, Jupiter and Saturn may be delineated in this way, and objects discovered which cannot be descried by means of the telescope. It might, perhaps, be considered as beyond the bounds of probability to expect that very distant nebulæ might thus be fixed, and a delineation of these objects produced which shall be capable of being magnified by microscopes; but we ought to consider that the art is yet in its infancy, that plates of a more delicate nature than those hitherto used may yet be prepared and other properties of light may yet be discovered which shall facilitate such designs."

Had Dr. Dick lived until the present day he would be amazed to see what portions of his prediction have in a measure come true. To him the most improbable of the things he forecast for photography to accomplish was the delineation of the nebulæ, and yet it is in this direction that photographic astronomy has most decidedly excelled. To use highly magnified images for photographing the details of the planets seemed to him to be among the first triumphs that were to fall to astronomical photography; yet to-day they are almost as far from realization as they were in the days when good Dr. Dick charmed his readers with vivid descriptions of the wonders of astronomy. I do not think the most active imagination could have foreseen in Dr. Dick's day the marvellous extent to which astronomy at the close of the nineteenth century would be influenced by that light-picturing process just then being developed by Daguerre and others.

After all, however, it is easy in the case of great discoveries of this kind to predict what they will amount to. This is usually done by immensely exaggerating all their possibilities and thus, by a happy chance, hitting one or more of their realities, for strict account is usually kept only of the hits in such cases, the misses being rejected by a charitable world as a matter of no importance. We are used to wonders in these days of wonders, and have a happy habit—from frequent practice—of correctly guessing the outcome of some of the great discoveries. But when Dr. Dick wrote, these things were not so easily foreseen, for the possibilities of the sciences were not so apparent then as they are now.

So great have become the possibilities of photography in the astronomical investigations of to-day that an account in detail of its accomplishments would far exceed the limits of this paper, and for that reason I shall be forced to a brevity in dealing with this subject that must necessarily pass over many of the interesting things photography has done for astronomy in its comparatively short lifetime.

It does not come within the province of a paper of this kind to deal with the question of priority in the discovery of photography (though something might be said on that point for America), as the process interests us only in so far as its application to astronomy is concerned.

It appears that on the very first announcement of Daguerre's wonderful discovery on the 19th of August, 1839, the celebrated French astronomer Arago, who addressed the Paris Academy on the subject, quickly foresaw the great advantage it must necessarily be to the science of astronomy, espe-

cially in the faithful delineation of the surface features of the sun and the moon, for these two objects, at least, were bright enough to register themselves with the sluggish materials then in use. It is specially gratifying to Americans that the first efforts to utilize the new discovery for the benefit of astronomy were made in this country, and that Americans have always been prominently identified with the process from its very earliest conception.

Within less than one year from the announcement of Daguerre's discovery, in March of 1840, Dr. John W. Draper, of New York City, had succeeded in getting pictures of the moon which, though not very good, foreshadowed the possibilities of lunar photography. Five years later the Harvard College Observatory may be said to have commenced its remarkable career of astronomical photography, when Bond, with the aid of Messrs. Whipple and Black, of Boston, succeeded in getting still better pictures of the moon with the 15-inch refractor. These pictures, on daguerreotype plates, seem to have been fairly good, and to have shown much detail, though the telescope was wholly uncorrected for the photographic rays. They attracted a very great interest in the subject, especially in England, but the difficulties encountered led to failures generally, except in the case of De La Rue, Dancer and one or two others. To Dancer is doubtless due the earliest success in lunar photography. Excellent photographs, it is said, were made by him as early as February, 1850. In 1858 De La Rue, using a 13-inch metal speculum, without clockwork, and guiding by following a lunar crater seen through the plate, made the most important of the early efforts at lunar photography. From this time De La Rue made the best pictures of the moon until the subject was taken up again in America in 1860 by Dr. Henry Draper, son of the illustrious John W. Draper. Like De La Rue, Dr. Draper constructed his own telescope, a 15½-inch reflector. With this instrument he secured excellent photographs of the moon, superior to any previously made, and capable of considerable enlargement. These pictures were the best taken until Lewis M. Rutherfurd began his remarkable work about 1865. Rutherfurd's work marked the most important step until then made in astronomical photography. From this time on he produced such admirable photographs of the moon that they have not been excelled until within the past few years. These were made with a refractor of 11-inches aperture which had been constructed under his immediate supervision. It was the first telescope corrected specially for the photographic rays. Some excellent lunar photographs, in the meantime, had been made with the great four-foot reflector of the Melbourne Observatory.

The completion of the Lick Observatory in 1888 marked another decided advance in the photography of the moon. The great focal length of the magnificent instrument gave an unenlarged image of the moon about six inches in diameter, which in itself was a great advantage.

The admirable lunar photographs made by MM. Loewy and Puiseux, with the equatorial coude at Paris, in the past few years have excelled anything yet made in this direction.

But what is shown by the best lunar photographs has not yet approached that which can be seen with a good telescope of very moderate size. The minute details are at present beyond the reach of photography, but its accurate location of the less difficult features is of the highest value. The greatest interest in any observation of the moon would be in any changes that might take place on its surface. It has long ago been shown that no changes on a large scale have occurred in recent times. It is, there-

fore, to the minuter details, if anywhere, that we must look for change in the moon, and these at present are much beyond the reach of the photographic plate.

The sun, from its abundance of light, offered special inducements to the early workers in photography. It would rather appear, however, that the moon had the most charm for the first photographic astronomers. This was doubtless due to the singular and wonderful wealth of detail its surface continually presented, while the sun, except for a few occasional spots, was at best only a blank surface. When carefully and conscientiously studied, however, it highly rewarded those who took up its study photographically.

The first picture of the sun seems to have been made on a daguerreotype plate by Fizeau and Foucault in 1845. During the total eclipse of the sun on July 28, 1851, a daguerreotype was secured with the Königsburg heliometer (2.4 inches in diameter and 2-feet focus) by Dr. Busch, which appears to have been the first photographic representation of the corona. It showed a considerable number of details quite close to the moon. But in the early eclipses the photographic work seems to have been mainly devoted to representations of the solar prominences, which at that time were as rarely seen as the corona itself. During the eclipse of 1869, however, Professor Himes secured a photograph which showed the brighter structure of the corona; similar pictures were also obtained during the same eclipse by Mr. Whipple, of Boston. The corona was also slightly shown on pictures made as early as 1860 by M. Serrat. None of them, however, showed more than slight traces of the corona, extending only for a few minutes of arc from the moon's limb. Nearly all the pictures seem to have been taken with an enlarging lens, which was doubtless used to get the prominences on a larger scale. Mr. Whipple, however, in 1869, did not use any primary enlargement, and this gave him a decided advantage in point of exposure time. In nearly all of these pictures the exposures, with the slowness of the then-existing plates, were evidently too short to show the corona, except perhaps in the case of Whipple, who gave 40 seconds exposure. The other observers seemed to be content with much shorter exposures.

The first really successful photographs of the corona were obtained at the eclipse of of December 22, 1870, when it was shown on the plate to a distance of about half a degree from the moon's limb. This picture, made by Mr. Brothers at Syracuse, Sicily, showed a considerable amount of rich detail in the coronal structure; and the same can also be said of the photographs of this eclipse taken by Colonel Tennant and Lord Lindsay's party. These seem to have been the first pictures to really show the great value of photography for coronal delineation. The eclipse of 1871 was still more successfully photographed, and an excellent representation of the corona, full of beautiful detail, was secured.

All of these pictures were made with the wet process, for the dry plate was not successfully used until about 1876, and it was five or six years later before it became generally useful or at all reliable. For some years previous to this, photographers had been at work with varied success upon different methods of preparing and sensitizing plates that could be used dry. Indeed, at the eclipse of 1871, at Baikul, India, it appears that Mr. Cherry used a dry plate on which he exposed a number of images of the sun before totality for the orientation of the eclipse plates. It would seem that he had only two of these plates and they were both intended to be used for orientation. The second plate, however, was broken before it could be used. It is probable they were known to be less sensitive

than the wet plates, which doubtless prevented their being used for the corona.

Though the pictures of 1870 and 1871 showed the value of the photographic method, it had so far failed to show the greater and fainter extensions of the corona. In speaking of the eclipse of 1871 and the success attained by photography at that time, it is well here to mention the evil influence that the old method of drawing had upon at least one observer. A Mr. Holiday had made observations of the corona from a housetop, and thus describes the result in his report: "As soon as the eclipse was over, I came down from the roof and plunged my head into cold water, for I was violently excited, and before breakfast I had made three drawings from my memoranda." If photography has done nothing more for astronomy than to prevent occurrences of this kind it would at least deserve lasting respect from a humane point of view.

In 1878 extensive preparations were made to observe the eclipse of July 29th of that year. Photography was to play an important part, though astronomers did not rely very strongly upon it, for it appears that all were prepared to make the customary drawings of the corona, and unfortunately each person faithfully carried out that purpose. A most suggestive illustration of the uncertainty of such work is found in the large collection of drawings published in a volume issued by the United States government relating to the eclipse of 1878. An examination of these forty or fifty pictures shows that scarcely any two of them would be supposed to represent the same object, and none of them at all closely resembled the photographs. The method of free-hand drawing of the corona made under the attending conditions of a total eclipse received its death-blow at that time, for it showed the utter inability of the average astronomer to sketch or draw under such circumstances what he really saw.

At this time the dry plate was still in its infancy, and the results with it ranged from failure up to a fair picture of the corona. The greatest extension of the corona obtained, however, seemed to be about half a degree from the moon's limb, while Professors Newcomb and Langley traced it nearly six degrees with the eye alone. The results, nevertheless, were highly important, and they demonstrated the success of photography for this class of work.

One of the cameras at this eclipse was put in charge of a private soldier, with instructions to give an exposure of 65 seconds. The instructions were faithfully carried out, but as no one had told him to draw the dark slide the plate remained unexposed.

The total eclipse of 1882 proved to be of special interest, from the fact that a small unknown comet was then in the immediate neighborhood of the sun, and was seen with the naked eye during the eclipse. The increased sensitiveness of the plates then in use secured a strong impression of this object. The known history of the comet is comprised within the few minutes of totality of that eclipse, for it was never seen afterwards.

In the eclipse of 1886 photography again held an important position. But the extremely humid climate of Granada (one of the observing stations) and the necessity of employing volunteer observers led to numerous disasters, such as the failure to get the sun's image on the sensitive plate in the most important instrument; the breaking of the polar axis just before totality in the next important instrument; the failure of an assistant to make the exposures with another until totality was all but over; the fact that two native policemen stood in front of the photometer during totality; the two weeks' delay of the steamer in getting

away from the island; the seizure of the plates by the customs officials on arrival at New York, and, after their rescue, the subsequent delay for want of time to develop the plates, until May of next year, when they had undergone decomposition, so that the results were not as good as might have been expected.

The closing of the year 1888 and the opening of 1889 brought one of the most important eclipses that had yet occurred from a photographic standpoint. Certainly no previous eclipse, nor any since, so far as that is concerned, was photographed by so many different persons, and with such a varied assortment of cameras, telescopes, etc. The path of this eclipse lay across Nevada and California, and every photographer, amateur or professional, near the line of totality took part in the work. The amateur photographers of San Francisco and Oakland banded together under the leadership of Mr. Charles Burckhalter and photographed the eclipse in a systematic manner, the result being a most excellent collection of negatives of the corona. In some of these pictures the coronal streamers were carried to a far greater extent than at any previous eclipse; especially was this so in the photographs made by two of the amateur photographers, Messrs. Lowden and Ireland. At this eclipse the lot fell to the writer to make the photographs for the Lick Observatory. But at this time the Observatory had no instruments suitable for the work. To secure as large an image as possible with the poor equipment at hand, a $3\frac{1}{2}$-inch visual objective by Alvan Clark was selected. This lens, after being reduced to $1\frac{3}{4}$ inch in diameter and mounted in an oblong box fastened to a polar axis driven by the clockwork belonging to the 12-inch equatorial, was found to give a fairly good photographic image. With this and two small photographic cameras, nine negatives of the corona were secured. The best of these was one made with the Clark visual objective. By extreme care in development, this negative not only showed the exquisite polar systems of streamers and the details of the corona close to the moon, but also carried the coronal extensions a great distance along the ecliptic. This was by far the most successful eclipse photographically of any that had yet been observed, and forever set aside as worthless the crude and wholly unreliable free-hand sketches and drawings previously depended upon.

The eclipse of December 21, 1889, was successfully photographed, among others, by Mr. Burnham and Professor Schaeberle, comprising the Lick Observatory eclipse expedition which was sent to Cayenne. It was at this eclipse that Father Perry lost his life through the trying climatic conditions. With the sickness of death upon him, this brave man, fearless in his duty, stood by his cameras and carefully carried out his program during the eclipse, only to collapse at its close and die a few days later on the vessel that was carrying him away from the fateful spot.

The eclipse of 1893 was successfully photographed in Brazil, Africa and Chile. Professor Schaeberle made arrangements for the photography of the corona on a large scale, and with his apparatus at Mina Bronces, Chile, secured a fine series of photographs with a photo-heliograph of 40-feet focus, which he mounted on a hill sloping towards the sun. The image was formed by a stationary lens five inches in diameter upon a large sensitive plate which was moved by clockwork to counteract the sun's motion during the few minutes of the eclipse. In these pictures the image of the sun was on such a large scale that the coronal details could be very accurately studied. Upon these plates Professor Schaeberle found a hazy ill-defined spot at forty minutes' distance from the sun's center. This he sub-

sequently found also on the African and Brazilian plates, taken by the English and American astronomers. This object was in motion away from the sun, as shown by the photographs, which covered an interval of 2 hours and 36 minutes of absolute time. Professor Schaeberle believes this was a comet. It is not impossible, however, that it was a mass of coronal matter moving out from the sun, such as has been shown by the spectroscope frequently to occur in the case of solar prominences. The fact that the object seemed to be connected with the sun by a coronal streamer would rather favor the explanation. The drawing given in *Astronomy and Astro-Physics*, p. 307, Vol. XIII., seems to further support this idea.

During the solar eclipse of 1896 the sky was cloudy at nearly all the stations, and especially where the most elaborate preparations had been made for photographic work. A few photographs were obtained, however, some of which, with very small lenses, showed the coronal extensions to a great length. Mr. Burckhalter, of Oakland, Cal., had arranged an ingenious device for grading the exposures of the Corona. Clouds unfortunately prevented the trial of this experiment. The most important photographic work at this eclipse was the photographing of the flash spectrum, or the momentary reversal of the Fraunhofer lines which occurs when the edge of the sun disappears behind the moon or reappears from it, and for an instant exposes the reversing layer, which was first seen by Professor Young at the eclipse of 1870. This extremely important picture was made by William Shackleton, a young Englishman, who patiently waited and watched the spectrum at the edge of the sun, and at the instant of the reversal of the lines exposed a plate which caught, for the first time, the fugitive bright lines which are only visible for about a second. This photograph was a triumph for photography, for the record of the phenomenon now does not rest upon the authority of any hasty observations, but remains a permanently visible record.

Our record closes with the eclipse of January 22, 1898, which was photographed in India by American and English astronomers. The photograph of the flash spectrum was successfully repeated by many observers. The coronal extensions were carried to a greater extent than at any previous eclipse, by photographs secured with a very small lens by Mr. and Mrs. Maunder.

In speaking of the photography of the corona it is well to mention the extremely interesting experiments of Dr. Huggins in an endeavor some years ago to photograph it without an eclipse. By the use of absorbing media, and later with extremely short exposures, he obtained very corona-like appearances, and it is not yet certain that they were not true coronal forms. Such experiments should be tried at very high altitudes in a pure atmosphere, and it is to be hoped that these efforts will be again undertaken under more favorable conditions.

The transit of Venus across the sun's disc in 1882 was very successfully photographed, and the measures of the pictures made by the Americans has given a good redetermination of the solar parallax. A fine series of photographs of this transit with wet plates was obtained by Professor D. P. Todd at the Lick Observatory. This was six years before the completion of the Observatory.

There is no question but that Janssen, of Meudon, succeeded many years ago in making the best photographs of portions of the sun's surface that have yet been made. These pictures show the granulation of the solar surface and the details of the sun spots with admirable clearness. Janssen has always used the old wet-plate process, which seems to give the best results in solar work. The instrument with which his work is done is a very crude affair. The

lens, 5 inches in diameter, is placed in a wooden box, which is mounted on an old camera stand on rollers. It is not provided with clock work. When Janssen wishes to make a photograph of the sun he wheels this primitive affair, stained and daubed with nitrate of silver, from a shed on to a platform, elevates it towards the sun, makes an exposure with a rapidly moving slit, and secures a photograph which, so far, but few have approached in excellence. These pictures are enlarged by a secondary lens in the camera box to about twenty inches in diameter. One peculiar feature of these photographs is the frequent presence of blurred regions, in striking contrast to the generally exquisite sharpness of the granular surface. These disturbed regions are believed by Janssen to be due to actual disturbances on the sun's surface, and, therefore, to be true phenomena of the sun. I have always had the impression that these features are simply due to the presence of small areas of bad seeing which are passing at the moment of exposure; that is, they are the effects of small local disturbances in our own air, such as every visual observer is familiar with in night work. I remember having once secured a photograph of the moon with the 12-inch of the Lick Observatory which showed just such a blurred spot on its surface. This question could be easily settled with a few exposures made a minute or so apart, for if the blurred appearance repeats itself at the same point on the sun's disc, then it can not be due to local atmospheric disturbances. Doubtless M. Janssen has long ago decided this question, but, if so, it has escaped my notice.

For the first successful photographs of the sun's surface, however, we must return to America. The first pictures to show this granulation and the details of the sun spots were taken by Lewis M. Rutherfurd in 1870. These pictures were also made with the collodion, or wet process.

From the importance of a more thorough understanding of the effects of the sun upon the climate of the earth, daily photographs of the solar surface are made at a number of observatories, principally at Greenwich, Kew and in India. These have been kept up for a great many years. The Lick Observatory has in recent years also taken up this subject. It is scarcely probable that a single day goes by without photographs of the sun being made at some one of these observatories. Thus a valuable record is kept of the changes taking place on the solar surface. Just what effect these sun storms have upon the earth is not yet definitely understood, but there seems to be an almost certain connection between some of the solar disturbances and terrestrial magnetic storms, so that when the sun is violently agitated a corresponding disturbance of the earth's magnetism occurs. It is not yet seen just how these disturbances may affect the weather; so far the testimony seems inconclusive, and local conditions on the earth may fully compensate for any effect solar storms might have here. In the meantime the work done in this connection at Greenwich and other places will continue to grow in importance. One thing that this repeated and constant photographing of the sun has proved is the non-existence of the so-called intra-mercurial planets, which before the days of photography were so frequently seen transitting the sun, by Lescarbault and many others. No strange thing, aside from an alleged comet, which was afterwards traced to a stain on the photographic film, has been shown on any of these photographs, with the exception, perhaps, of one of the sun photographs made in India which caught a distant bird in its flight and showed clearly its head and outspread wings projected against the sun.

Just as this continuous photographing of

the sun's surface has forever disposed of the alleged frequent transits of intra-mercurial planets, so will the photographic plate finally, when it has attained more perfection in dealing with the planets, show that many of the strange features ascribed to the surfaces of some of them do not exist.

As I have said, the early photographs of eclipses seem to have been made with the sole end in view of securing pictures of the solar prominences. This was very important at first, for by the photographs it was proved that they were true solar phenomena. Possibly also in the very first photographs a picture of the corona was considered a hopeless matter on account of the lack of sensitiveness of the plates. The eclipse of 1868 is memorable for having shown Janssen and Lockyer that the visibility of the prominences did not necessarily depend upon a total eclipse of the sun. They found that by the aid of the spectroscope the prominences could be seen and studied at any time. This was an extremely important step, and placed our knowledge of the nature of the prominences upon a firm and lasting footing. The fact that these objects could be made visible with the spectroscope soon suggested to Professor Young the idea that they might also be photographed at any time ; and in 1870 he made efforts to secure impressions of them upon the photographic plate, and met with partial success. To photograph successfully these objects, however, required the invention of a special instrument, for the older methods must necessarily result in failure. In observing the prominences visually with the spectroscope it is necessary to examine them through a slit which is very narrow compared with the height of the prominences. Only a small section of the prominence can, therefore, be seen at once, and to see it all the slit must be moved over the prominence. If the slit is widened more of the object is shown, but at the same time such a flood of light is admitted that it is lost in the glare. If an instrument could be devised whereby the slit could be moved in front of a photographic plate, successively exposing to the plate all parts of the prominence, it will readily be seen that the entire image could be photographed. To do this there must be two slits moving in perfect unison—one placed across the sun in front of the grating or prism, the other in front of the photographic plate and adjusted perfectly to the spectral line of the prominence so as to exclude all light save that emitted by the prominence itself, and thus, by the gradual motion of these two slits, the entire object is successively uncovered and an exact photograph secured of it.

The solar prominences consist mainly of incandescent hydrogen and calcium. The best results are secured by calcium alone. It is curious to see photographs of the same prominence made by using the hydrogen or calcium lines independently; these pictures often differ considerably, thereby showing the peculiarity of distribution of the calcium and hydrogen in the same prominence. The two components are differentiated, and it is thus shown just what part each component takes in the composition of the prominence. To make one of these pictures takes several minutes of exposure, during which time the slits slowly travel over the region of the prominence. This extremely ingenious device owes its existence to the inventive genius of Professor Hale, who devised and built the first instrument of this kind, and secured the first actual spectroscopic photograph of the prominences. These first pictures were made in 1891. It is, therefore, now a matter of no great labor to make not only photographs of single prominences at any time, but through a further ingenious extension of the possibilities of the instrument it is made to move across the entire sun's disc, thus securing every prominence at that time visible.

By hiding the sun's image by an occulting disc in the first sweep, and then making a second similar but more rapid sweep with the sun's image uncovered, the sun itself with all its faculæ, spots, etc., is impressed in the blank space left for it, and a complete picture of the sun and all its surroundings, with the exception of the corona, is secured. This is the method employed by Professor Hale. These pictures, however, show only those features of the sun which are due to hydrogen or calcium, and the solar surface thus appears very different from the telescopic view of it. The calcium regions come out with extraordinary distinctness, so much so, indeed, as at times to obliterate completely the sun spots, which at that moment are so distinct to the eye with the same telescope. Admirable work of this kind has also been done by M. Deslandres, of the Paris Observatory, who has devised an instrument similar to that of Professor Hale.

From the first photograph of a star by Bond in 1850 to the present time, stellar photography has gradually risen to a prominence as remarkable as it is important. The real increase of importance in this work, however, has occurred within the past ten or fifteen years, since the successful introduction of the very rapid dry plate. The wet, or collodion process was poorly adapted to the photography of the stars, and of no use whatever for comets and nebulæ. As implied by the term 'wet process,' the plate must remain wet through the entire work from its first coating with collodion until its final washing as a negative. The exposure time must, therefore, be very limited. Not only was the exposure of short duration (from fifteen to twenty minutes), but the plate was very slow in its action compared with the dry plate of to-day. The combination of these two difficulties made it impossible to photograph anything except the brighter stars. Dr. Gould at Cordoba managed to increase the exposure time by keeping a stream of water playing over the plate. This, however, might cause a deterioration of the film. With the inherent difficulties of the wet plate to contend with, it is little wonder that no faint stars, nebulæ or comets were photographed. Notwithstanding this, the photographs of the star clusters, etc., of the southern skies obtained, under the direction of Gould with an 11-inch photographic refractor by the wet process, were of the highest value, and showed, upon measurement, a striking agreement in accuracy with visual work. The same can be said of Mr. Rutherfurd's photographs of the Pleiades, Præsepe, etc., which were made prior to Dr. Gould's, and which were the first photographs of this kind. These extremely valuable photographs of Rutherfurd are now receiving a most thorough measurement under the careful supervision of Professor J. K. Rees, of Columbia College, where Mr. Rutherfurd's negatives are stored. To this institution Mr. Rutherfurd left his telescope and measuring instruments.

In 1857 Bond had shown, by measurement of a series of photographs of the double star Mizar, that the highest confidence could be placed in measures of star plates. This has been fully verified in late years by Gill, Elkin and others. Dr. Elkin showed, in 1889, that measures of a photograph of the Pleiades taken by Mr. Burnham, with the great telescope at Mt. Hamilton, had equal value with his heliometer measures of the same stars.

From the necessary conditions the collodion process could make no advance in stellar photography. Previous to 1876 experiments had been made to get a workable dry plate, and for the next six years more or less success had been attained in their manufacture. But the photographers themselves took hold of these plates with

much caution because of their uncertainty. By 1881 or 1882, however, they were beginning to be used and gave considerable promise of their ultimate value, as was shown by the photographs of the comet of 1881, which were made by Draper and Janssen. These were the first photographs ever made of a comet. Efforts had been made to secure pictures of Donati's comet, in 1858, but without success.

In the fall of 1882 the world was thrilled by the advent of a magnificent comet which suddenly appeared near the sun in September, and for the next four or five months delighted astronomers with the splendor of its display. Attracted by the great brilliancy of the comet, Dr. Gill, at the Cape of Good Hope, with the aid of a local photographer and his photographic lens, secured a fine series of photographs of the comet with dry plates. When these photographs reached the northern hemisphere they attracted a great deal of attention, not only on account of the comet itself, but also from the number of stars that were impressed on the plates. At this period the Henry Brothers were making a chart of the stars along the ecliptic in their search for asteroids. They had at this time reached the region of the Milky Way, and the marvellous wealth of stars they encountered upon entering the boundaries of that vast zone completely discouraged them in their endeavors to carry their charts through the rich region traversed by the ecliptic. While hesitating as to the advisability of continuing their work the photographs of the great comet came to their notice. They were struck with the great number of stars shown on these pictures along with the image of the comet. The idea at once occurred to them that they could use this wonderful process to make their charts. It was to this simple incident that the active application of the stellar photography of to-day is due. They began at once the construction, with their own hands, of a suitable photographic telescope of 13½ inches' diameter for the photography of the stars. This instrument was soon finished, and the astronomical world knows to-day what wonderful results these men produced with it; the exquisite star pictures which were marvels of definition, the photographs of the nebulæ, of Saturn and Jupiter, the moon, etc., were perfect revelations.

In 1859 Tempel, at Florence, Italy, had found a diffused cometary-looking nebula connected with and extending southwesterly from the star Merope, of the Pleiades. From that time on astronomers wrangled over this object, which many of them believed had no existence. One of the first things done by the Henry Brothers was to photograph the Pleiades. These pictures showed nebulous strips near Merope, and though they did not resemble any that had been drawn by the numerous observers of the Merope nebula they rather confirmed the existence of Tempel's object. Upon these plates was shown a new nebula connected with the star Maia where none was previously known. It required the most powerful of existing telescopes to verify this visually. This was finally done, however, and it then began to dawn upon astronomers what great possibilities lay in the photographic plate for the detection and study of the nebulæ. It was soon seen that their light was strongly photographic; that it was really more actinic than visual. A later photograph with a longer exposure showed the Merope nebula just as the best observers had drawn it, and at the same time filled the entire group of stars with an entangling system of nebulous matter which seemed to bind together the different stars of the group with misty wreaths and streams of filmy light, nearly all of which is entirely beyond the keenest vision and the most powerful telescope. This was a revelation. The question had often been

asked whether it would ever be possible to photograph as faint a celestial body as could be seen with a powerful telescope. Here was the answer. It was not only possible to photograph some of the faintest objects seen in the telescope, but it was possible also to photograph some others which could never be seen in the sky. In one of his reports Admiral Mouchez called attention to the fact that the only way they could see the satellite of Neptune at the Paris Observatory was on the photographs made by the Henry Brothers, for they had no telescope sufficiently powerful to show it visually.

The Henrys applied themselves assiduously to celestial photography, with the most remarkable success. They led the world in this work. While they were at the height of their activity astronomers elsewhere were but beginning to awaken to the great importance of the subject. And yet there seems to have been essentially no public recognition of the work of these two men, to whom astronomy owes so much. In personal appearance and temperament they are so extremely dissimilar that one would scarcely take them to be brothers. Up to the time they began their photographic work they had between them discovered fourteen asteroids, by the slow and tedious visual process of picking them out by their motion from the countless thousands of small stars. If one examines a list of the asteroids he will be struck with the manner in which these fourteen small planets are recorded. According to this list the first one of these was discovered in 1872 by Prosper Henry, the next one by Paul Henry, and so on alternately throughout the entire fourteen until 1879, when the last one found was attributed to Paul Henry. It is a curious fact, and one which will be readily understood by all who are acquainted with the unselfish affection existing between these two brothers, that the credit for the discovery of these fourteen minor planets is ascribed alternately to Prosper and Paul Henry. It is likely that we shall never know which brother discovered any one of these planets.

Singularly enough, the photographic plate not only did away with the necessity of making these charts by eye and hand to facilitate the discovery of asteroids, but it also did away with the necessity of the charts themselves for that purpose, for the little planet, which is moving among the stars, now registers its own discovery by leaving a short trail—its path during the exposure—on the photographic plate. The first of these photographic discoveries of asteroids was made by Dr. Max Wolf in 1892. They are now found wholesale in this manner by photography.

It was the success of the Henry Brothers' work that led to the International Astro-Photographic Congress which met at Paris in 1886. It was their work that caused this Congress to meet at Paris. The Congress adopted the Henry Brothers' lens as a model for the instruments to be used, and the work of this great undertaking was based on that of the Henry Brothers. It was stated once by Admiral Mouchez that every object glass at the Paris Observatory had either been made by the Henry Brothers or refigured by them.

Perhaps, as Dr. Dick himself thought in the early days of photography, the most unpromising subject for the photographic plate to deal with was the nebulæ. Most of these objects appeared so feeble in their light that but little encouragement in that direction was offered the celestial photographer.

One of the brightest and most promising of the nebulæ is that in the sword of Orion, and this was naturally one of the first of these objects to receive photographic attention. In September, 1880, Dr. Henry Draper began the photography of the nebu-

læ with this object, and succeeded, with 51 minutes' exposure, using the dry plate, in getting a good picture of the brighter portions of the nebula. This was the first nebular photograph. With 104 minutes' exposure in March, 1881, with an 11-inch refractor, he secured a still better plate, which showed stars down to the 14.7 magnitude, which were visually beyond the reach of the same telescope. But in March, 1882, he obtained the best picture of this wonderful nebula, with an exposure of 137 minutes. These pictures marked a new era in the study of the nebulæ. When these results were communicated to the French Academy by Dr. Draper, Janssen took up the subject with a silver-on-glass mirror of very short focus, having the extraordinary ratio of aperture to focus of $\frac{1}{3}$; the aperture being 20 inches, with a focus of 63 inches. This remarkable instrument was constructed in 1870 for the total solar eclipse of 1871. With this Janssen found it easy to photograph the brightest parts of the nebula with comparatively short exposures. This extremely powerful photographic instrument seems to have been unused for the past fifteen years; but very recently it has been brought into use again, I understand, with the most astonishing results in photographing the nebulæ. Unfortunately for science, the death of Dr. Draper, in 1882, put a stop in America to the work he had inaugurated. But it was at once taken up in England by Common, who, with a three-foot reflector, attained rapid and immediate success. His photographs of the great nebula of Orion are still classic. They were a great advance over the work of Draper, for the reflector was not only a larger telescope, but was also better adapted for photographic purposes, and especially for photographing the nebulæ. In January of 1883, with only 37 minutes' exposure, he secured what was by far the most striking and beautiful picture which had yet been taken of the great nebula. These pictures greatly extended the region of nebulosity, and the delicate details were also better shown.

The writer remembers how much he was impressed a few years later with the beauty of one of Common's photographs. It created in him the first ambition to do work of this kind. Indeed, this picture, and one of a densely crowded region of a part of the constellation of Cygnus, by the Henry Brothers, first called his attention to the great value of the photographic plate for astronomical purposes. It was at this time that the writer conceived the idea of photographing the Milky Way, though the experiments were not then successful for the want of a proper instrument. The great nebula, which has always had such a fascination for astronomers, was subsequently taken up by Isaac Roberts, who, by very prolonged exposures, still further extended the nebulous region and secured very beautiful pictures of it. Among the finest photographs of this object that have been made in recent years is one taken by Dr. H. C. Wilson at Northfield, Minn., with an 8-inch photographic refractor with an exposure of nine hours. The amount and sharpness of detail shown on this beautiful photograph is very striking, and essentially embraces all that has been done on this nebula by photography up to the present time.

E. E. BARNARD.

YERKES OBSERVATORY.

(To be concluded.)

THE INTERNATIONAL CONGRESS OF ZOOLOGY.*

THE Fourth International Congress of Zoology met at Cambridge on Tuesday, August 23d, and the four following days. There were about 300 members present. The attendance from America was scarcely

* Based on reports in the London *Times*.

as large as might have been expected, especially when compared with the representation from Continental countries. The Vice-Presidents elected were Professors R. Collett, von Graaf, Haeckel, R. Hertwig, Jentink, Marsh, Milne-Edwards, Mitsukuri and Salensky.

The scientific proceedings of the Congress were opened by Sir John Lubbock's presidential address, which was delivered in the Cambridge Guildhall. In accordance with the example set by the three previous Presidents — Professor Milne-Edwards, Count Kapnist and Professor Jentink —Sir John Lubbock's address was brief. He began by reading a letter to the Congress from Sir William Flower, and expressed his deep personal regret at that gentleman's absence and his sense of the loss the Congress had thus sustained. He then proceeded to say: I am painfully conscious how inadequately I can fill Sir William Flower's place, but my shortcomings will be made up for by my colleagues, and no one could give our foreign friends a heartier or more cordial welcome than I do. The first Congress was held at Paris in 1889 and was worthily presided over by Professor Milne-Edwards, whom we have the pleasure of seeing here to-day. The second Congress was held at Moscow in 1892, under the presidency of Count Kapnist and under the special patronage of his Imperial Highness the Grand Duke Serge. The third Congress was at Leyden in 1895, under the presidency of Dr. Jentink, Director of the Royal Museum, under the patronage of the Queen-Regent. We assemble here to-day under the patronage of his Royal Highness the Prince of Wales, with the support of her Majesty's government and under the auspices of the University of Cambridge.

Such meetings are of great importance in bringing together those interested in the same science. It is a great pleasure and a great advantage to us to meet our foreign colleagues. Moreover, it cannot be doubted that these gatherings do much to promote the progress of science. What a wonderful thing it would be for mankind if we could stop the enormous expenditure on engines for the destruction of life and property and spend the tenth, the hundredth, even the thousandth, part on scientific progress. Few people seem to realize how much science has done for man, and still fewer how much more it would do if permitted. More students would doubtless have devoted themselves to science if it were not so systematically repressed in our schools; if boys and girls were not given the impression that the field of discovery is well-nigh exhausted. We, gentlemen, know how far that is from being the case. Much of the land surface of the globe is still unexplored; the ocean is almost unknown; our collections contain thousands of new species waiting to be described; the life-histories of many of our commonest species remain to be investigated, or have only recently been discovered.

Take, for instance, the common eel. Until quite recently its life history was absolutely unknown. Aristotle pointed out that eels were neither male nor female and that their eggs were unknown. This remained true until a few years ago. No one had ever seen the egg of an eel, or a young eel less than five centimeters in length. We now know, thanks mainly to the researches of Grassi, that the parent eels go down to the sea and breed in the depths of the ocean, in water not less than 3,000 feet below the surface. There they adopt a marriage dress of silver and their eyes considerably enlarge, so as to make the most of the dim light in the ocean depths. In the same regions several small species of fishes had been regarded as a special family known as leptocephali. These also were never known to breed. It now appears that they are the larvæ of eels, that known

as leptocephalus brevirostris being the young of our common fresh-water eel. When it gets to the length of about an inch it changes into one of the tiny eels known as elvers, which swarm in thousands up our rivers. Thus the habits of the eel reverse those of the salmon. I must not, however, go into detail, but I will take one other case—the fly of the King Charles oak-apple, so familiar to every schoolboy. In this case the females are very common; the eggs were known. But no one had ever seen a male. Hartig in 1843 knew 28 species of cynips, but in 28 years' collecting had never seen a male of any of them. Adler, however, made the remarkable discovery that the galls produced by these females are quite unlike the galls from which they were themselves reared; that these galls produced flies which had been referred to a distinct genus and of which both males and females were known. Thus the gall flies from the King Charles oak-apple (which are all female) creep down and produce galls on the root of the oak, from which quite a dissimilar insect is produced, of which both sexes occur, and the female of which again produces the King Charles oakapple. This is not the opportunity to go into details, and I merely mention this as another illustration of the surprises which await us even in the life history of our commonest species.

Many writers have attributed to animals a so-called sense of direction. I have shown that some species of ants and bees have none. Pigeons are often quoted, but the annals of pigeon-flying seem to prove the opposite. They were jumped, as it were, from one point to another. We know little about our own senses—how we see and hear, taste or smell, and naturally even less about those of other animals. They are no doubt in some cases much acuter than ours, and have different limits. Animals certainly hear sounds which are beyond the range of our ears. I have shown that they perceive the utraviolet rays, which are invisible to us. As white light consists of a combination of the primary colors this suggests interesting color problems. Many animals possess organs apparently of sense and richly supplied with nerves which yet appear to have no relation to any sense known to us. They perceive sounds which are inaudible to us; they see sights which are not visible to us; they, perhaps, possess sensations of which we have no conceptions. The familiar world which surrounds us must be a totally different place to other animals. To them it may be full of music which we cannot hear, of color which we cannot see, of sensations which we cannot conceive. There is still much difference of opinion as to the mental condition of animals, and some high authorities regard them as mere exquisite automata, a view to which I have never been able to reconcile myself. The relations of different classes to one another, the origin of the great groups, the past history of our own ancestors, and a hundred other problems—many of extreme practical importance—remain unsolved. We are, in fact, only on the threshold of the temple of science. As regards these profound problems animals are even more instructive than plants. Ours is, therefore, a delightful and inspiring science.

We are fortunate in meeting in the ancient University of Cambridge, a visit to which is under any circumstances delightful in itself from its historic associations, the picturesque beauty of the buildings, and as the seat of a great zoological school under our distinguished colleague Professor M. Foster.

At the close of the presidential address, which was warmly received, the Vice-Chancellor, Dr. Hill, welcomed the Congress on behalf of the University. Greetings were presented by representatives of foreign na-

tions: Professor Alphonse Milne-Edwards, Director of the Natural History Museum, for France; Professor Schulze, of Berlin, for Germany; Professor Hubrecht, of Utrecht, for Holland; Professor O. C. Marsh for the United States; Professor Salensky, of Odessa, for Russia, and Professor Mitsukuri, of Tokio, for Japan, after which Professor Newton, Chairman of the Reception Committee, acknowledged the graceful expressions of the previous speakers. He claimed that Cambridge attached more value to zoology than did any other university, and exhibited a copy of what he regarded as the first book on zoology which treated the subject in the modern spirit. It was published in 1544 by William Turner, a Fellow of Pembroke Hall.

The most important features of the scientific proceedings of the Congress were two discussions, one on the position of sponges in the animal kingdom, the other on the origin of the mammalia. The former discussion was opened by M. Ives Delage, who said he would limit his remarks to one point in the argument. The doubt as to the affinities of sponges was whether the group Spongida was to be regarded as a distinct phylum which had arisen quite independently, or whether it was only a branch of the Cœlenterate phylum. All zoologists admitted that the sponges lacked several characters found in the typical Cœlenterates, but it was disputed whether these characters necessitated the separation of two groups. The speaker believed that one of the differences was so important as to preclude the inclusion of sponges in the same group as Cœlenterata. In the sponge larva there were two types of cells—collar-cells bearing each a long whip-like flagellum and large rounded cells containing the yolk. The former occurred at the upper end of the larva, the latter at the lower end. From analogy with the Metazoa it would be expected that the lower cells would pass inwards and form the internal element of the larva. But observation showed that the the reverse process occurred. Balfour thought it better to assume that the observers were in error rather than that such an abnormal development could occur. There was, however, now no doubt that the observers were correct, and that two layers of the blastula stage in the sponge were formed in the opposite way to that which occurred in other animals. That was to say, the layer which had the histological character of an ectoderm had the evolution of an endoderm, and the layer that histologically was an endoderm passed to the outside and acted as the surrounding ectoderm. The possibility of this reversal Professor Delage illustrated by reference to experiments on the development of larval echinoderms in which, by raising the temperature, a similar inversion of the two layers was sometimes produced. He, therefore, held that the change was actually in the position of the cells, and not that the endoderm cells had acquired the characters of ectoderm cells, and *vice versa*. He concluded that the sponges began to develop along the same line as the rest of the Metazoa, and that they separated from the main Cœlenterate branch at the stage corresponding to the blastula.

Mr. E. A. Minchin, of Oxford, remarked that it was not until nearly the middle of the present century that the investigations of Dujardin and of Dr. Dobie, of Chester, proved that sponges were animals and not plants. After this point had been settled most observers regarded the sponges as Protozoa, a view based mainly on the histological structure of tissues. When improved methods demonstrated the relations of the constituent cells this theory was discredited; Leuckart, in 1854, pointed out the sac-like form of the adult sponge, which he compared to a polype devoid of tentacles and thread-cells. Haeckel placed

this Cœlenterate theory on a sound basis by his work on the larvæ, which he described as formed of two layers, an ectoderm and an endoderm. The Cœlenterate theory, as modified by the beautiful researches of the Chairman, soon became dominant. It was based on architectural considerations, which rendered the reference of the sponges to the Protozoa impossible. But it did not equally disprove the descent of the sponges from that group. Hence two further rival views had been advanced: (1) that the sponges, though Metazoa, are not Cœlenterata; (2) that the sponges are not Metazoa at all, but have been developed independently. The speaker summarized his own researches on the development of the Ascone sponge, *Clatharina blanca,* and concluded that the evidence appeared to favor the independent descent of the sponges from the Choanoflagellata.

The general discussion was begun by Professor Haeckel, who summarized the historical progress of opinion. He still clung to the Cœlenterate theory, because he thought that the remarkable resemblance between the blastula stages of sponges and of admitted Metazoa, such as some mollusca and amphioxus, proved that the whole metazoan phylum was monophyletic in origin. Dr. Vosmaer, of Utrecht, rather regretted that he had been invited to join in the discussion, because it was very unpleasant for a specialist on a group to be forced into a confession of ignorance regarding it. All he could say was that they did not know the exact position of the sponges in the animal kingdom. Mr. Savile Kent read a statement arguing that the sponges must be the descendants of the Choanoflagellata, as the collared cells of the two groups were known in no other animals and agreed so precisely that they must be homologous. He sketched cases in which Choanoflagellata occurred as aggregates of collared cells resting on cells without the flagella, and thus reproducing the typical structure of the walls of a sponge blastula. He urged that workers on the sponges should acquire some personal acquaintance with the Choanoflagellata. Professor Schulze closed the discussion by a few general remarks, in which he upheld the Cœlenterate view of the sponge affinities. He said all Metazoa could be divided into two sets, those with the elements arranged radially and those in which they were bilateral. He regarded the sponges as members of the former division.

On the third day a discussion on the origin of the mammalia was opened by Professor Seeley, who began by remarking that 30 years ago birds and reptiles were united together owing to the discovery of many features in the skeletons of some fossil reptiles, previously known only in birds. But since then many reptiles have been discovered of which the skeletons show characteristic mammalian features. Accordingly the anomodont reptiles of South Africa and Texas have been united with the mammals as the group Theropsida. The distinctions, based on living reptiles and mammals, on which the separation of the two classes was founded, break down when applied to the fossils. Professor Seeley compared the skeleton of the anomodonts with that of the mammals, and showed, element by element, that there is a remarkable series of resemblances in structure between them. Thus the specialization of the teeth into canines, incisors and molars, once regarded as characteristic of mammals, occurs also among reptiles; and in the genus *Diademodon* there is a beauty of differentiation which can be paralleled only by the molars of insectivores. Similarly with the limbs, that of *Theriodesmus* was thought to prove that animal to be a mammal, but it is now known to be a reptile; and all through the limbs of the anomodonts there runs a strong mammalian strain. The marsupial bones

of the pelvic arch occur in the monotremes, and there is a suggestion of their presence in the anomodonts. In the case of the skull the articulation of the lower jaw in some anomodonts approximates to that of the monotremes, while in others they resemble the marsupials and higher mammals; further the supratemporal and quadrate jugal of Labyrinthodonts may also be represented in Ornithorhynchus, as they certainly are in Pariasaurus. The question is complicated by the fact that the anomodonts show resemblances to more than one mammalian type. For example, the teeth of Diademodont resemble those of the lemurs and of the rodents; and the Theriodont and and Dicynodont groups of the anomodonts show affinities in the two chief divisions of the mammals. Hence Professor Seeley concludes that, though the points of resemblance between the mammalian and anomodontian skeletons show the affinity of the groups, they do not render it probable that the anomodonts are the direct ancestors of the mammals, but only form a collateral line. For the common ancestor of both we must go back to the Devonian or even to the Silurian periods, and the interval between the mammals and the anomodont reptiles is now so small that there is a reasonable probability that it will be completely bridged by the discovery of further specimens.

Professor Osborn, of Columbia University, said that certain general principles were useful guides as to the probable nature of the ancestral mammal; in the present imperfect state of the paleontological record he preferred to commence by working backward from the well known comparatively recent forms. In the first place, mammals possess the power of rapid adaptation to their conditions of life. There have been four main centers of adaptive radiation, of which the best case is that of Australia, where the marsupials have acquired forms which among placental mammals are divided between different orders. The starting point of each adaptive radiation has been a small, unspecialized land mammal. Finally, it is probable that the ancestral mammal was omnivorous. Remembering these principles we can trace the line of mammalian descent backward; it leads us to the Jurassic, when the mammals were all small and belonged to three groups—the primitive insectivores, which have been regarded as marsupials, although there is no evidence to support that view; second, the multituberculata, which are probably early monotremes; third, the marsupials. Reversing the order of inquiry, Professor Osborn then referred to the fact that in the Permian there are three groups of reptiles, one of which is surprisingly mammalian in some of its characters, and tempts us to connect the herbivorous section of anomodonts with the monotremes. He thought, however, that the many striking points of resemblance between these reptiles and mammals were due to parallelism, similar characters having been independently acquired. He agreed with Professor Seeley that the anomodonts are not the direct ancestors of mammals, but are a collateral line. He disagreed with Professor Seeley when the latter sought for a much earlier common ancestor of the mammals and the anomodonts, as the speaker believes that an undiscovered and less specialized third subgroup of anomodonts will be found to be the true ancestor of the mammals. The Chairman, however, has shown that the mammalian egg is amphibian rather than reptilian in character; and if much weight is to be laid on this point, then the mammals may have descended from some reptile which retained certain amphibian characters.

Professor Marsh expressed his belief that the solution of this problem is still in the future. He referred to his discussions of

the question with Huxley in 1876 and with Balfour in 1881, and to subsequent progress due to paleontological discoveries. But in spite of these the great gulf between the mammals and reptiles is still unbridged, and he could not agree with Professor Seeley as to the complete collapse of the distinctions. Four points still remained. Great stress had been laid on the affinities between mammals and anomodonts, as shown by the differentiation of the teeth in the latter into three types; but other reptiles, which no one would regard as allies of the mammals, have the same specialization of the teeth, such as the Patagonian crocodile, *Motosuchus*, and the dinosaur, *Ceratopsia*. Again, there was no known reptile with two occipital condyles, as in the batrachians and the mammals. Reptiles had been described with double condyles, but he had examined the specimens in question, and the condyle in each case was really single and only cordate in shape. Thirdly, the absorption of the quadrate bone in the squamosal was not conclusive, as it occurred among plesiosaurs and dinosaurs as well as anomodonts, and in each case the quadrate bone was still in existence. Finally, in reptiles the lower jaw consists of several bones and in mammals of but one. He had examined the most mammalian of the reptiles, and the sutures between the bones were still apparent. The determination of certain bones as prefrontal he thought should be received with caution. He did not expect that the ancestor of the mammals would be found among the huge anomodonts, but among smaller animals.

Professor Haeckel said that he had discussed the problem with Huxley and Lyell 32 years before, and the former then strongly held the polyphyletic origin of the placental mammals, the carnivorous and herbivorous groups having descended respectively from carnivorous and herbivorous marsupials. This view was now untenable, and the speaker believed that the different series of placental mammals converge so nearly that they must all have been derived from one marsupial ancestor. Mr. Sedgwick said that embryological evidence had been referred to, but he thought it would help very little. For example, there could be no doubt that the ancestors of horses had many toes, those of snakes had limbs, and those of birds had teeth; but no trace of these conditions had been detected by embryology. If no light was thrown on such simple problems as these they had no right to expect any on more remote questions. Reference had been made to Professor Hubrecht's use of the characters of the mammalian ovum. The speaker said it must not be forgotten that in the one genus, *Peripatus*, the eggs vary more than they do in the whole of the mammals. He expected little help from paleontology, as the ancestors of nearly all existing groups lived in the pre-Cambrian period, and all traces of them had been lost. Professor Hubrecht, in closing the discussion, said, in reply to Mr. Sedgwick, that the value of embryology was destructive, not constructive. Its evidence was of value as prohibiting certain lines of speculation. He differed from his great teacher, Professor Haeckel, whose present views he thought untenable, since Hill and Semon had shown that in two genera of Australian marsupials have traces of a placenta been found, which in one case is deciduous. He predicted that one great battlefield in the future of this controversy would be over the question whether mammals had descended from oviparous ancestors.

Many important contributions were presented before the sectional meetings of the Congress, including papers by Professor Haeckel, Professor Milne-Edwards, M. Dubois, Professor Hubrecht, Professor Marsh, Professor Osborn and other leading

zoologists. Dr. Wardell Stiles, of Washington, announced that the Committee on Zoological Nomenclature, which had been appointed at Leyden, had drawn up a report. The Committee were not unanimous, and he thought it would save much time if the subject were not discussed at the present Congress. After the circulation of the Committee's proposals a more profitable discussion could be hoped for at the next Congress. Dr. Sclater, as senior member of the Committee, proposed that the report be referred back for further consideration to the Committee, with powers to add to their number. He thought this step necessary, as the last committee were not unanimous in their conclusions. The Committee had been too small. It consisted of six members, one from each of the leading nationalites, of which never more than four had met. He thought the Committee should consist of at least two representatives of each nationality. Dr. Sclater's motion was carried unanimously.

Numerous entertainments were promised, including a reception at the Cambridge Guildhall, a reception by the Master of Downing College and Mrs. Hill, and a concluding banquet at which speeches were made by Professors Möbius, Waldeyer, Blanchard, Milne-Edwards, Marsh, Osborn and Hubrecht.

Before adjournment Professor Möbius, the senior member of the German delegation, extended a formal invitation to the Congress to meet in Germany three years hence.

THIRD INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY, VIENNA, 1898.

The sessions of this Congress, extending through a week's time, were opened on July the 28th by a public reception held in the Aula of the University of Vienna, Austria.

The opening address was delivered by the President of the Committee on Organization, Professor Dr. von Perger, who took occasion in his remarks to refer to the importance, to the aims and the objects of Applied Chemistry.

Among the speakers who followed von Perger in addressing the assemblage were Professor A. Bauer; Director F. Strohmer, Secretary-General of the Congress; Dr. C. Lueger, burgomaster of Vienna, and Dr. Lieben, representing the Imperial Academy of Sciences.

The Austrian Ministers of State were appointed Honorary Presidents, and some of the delegates of foreign countries were honored by their election to the office of Honorary Vice-Presidents of the Congress.

After the motion made by C. Huck, Halle a. S., that the Committee of Organization be continued in office, had been unanimously adopted, Professor E. Buchner, Tübingen, delivered a most interesting lecture: Fermentation without Yeast-cells.

His exposition, freely illustrated with experiments, was followed by all present with the closest attention; all discussion of the subject was, however, deferred to a later and more opportune occasion.

This ended the morning's doings. In the afternoon organization of the various sections was speedily effected, and thereafter most of these held sessions both mornings and afternoons during continuance of the Congress.

These gatherings of the members were most truly international in their make-up. Predominating in number in most of them were naturally the Austrians, the courteous hosts of the occasion.

To select, at hap-hazard, but a few of the many who took an active part in the proceedings: Strohmer, Wolfbauer, Kutschera, Ludwig, Jolles, Stift, Heger, Murmann, Strache, Teclu, Seidel, Werber

and Schwackhöfer. Germany had among its eminent representatives A. Herzfeld, Weinstein, Beckurts, Dietrich, F. Fischer, Winkler, Caro, Vogel, von Lippmann, Le Blanc, H. Claassen, C. Huck and Holde. France counted among her deputies Moissan, Tommasi, Gallois, Dupont, Aulard, Pellet, Dehérain, Durin, Weisberg, Saillard, Carnot, Aimé, Lindet and Deutsch.

From Russia there had come Wróblewski, Slaski, Jawein and Fischmann; Greece was represented by Christomanos, of Athens; Italy by Nasini; Holland by Lobry de Bruyn, van Ekenstein and van 't Hoff; Denmark by Sörensen.

Among the Americans present were Dr. Flint, representative of the U. S. Navy; H. W. Wiley, Washington, representing the United States; Rising, California; Watts, Philadelphia; Krause, Wyatt and Wiechmann, New York.

The principal sections, twelve in number, were:

General analytical chemistry and chemical instruments.

Chemistry of food, medical and pharmaceutical chemistry.

Agricultural chemistry.

Sugar industry.

Zymology.

Oenochemistry.

Chemical industry of inorganic substances.

Metallurgy, Explosives.

Chemical industry of organic substances.

Chemistry of the graphic industry.

Questions of instruction and general affairs of chemistry.

Electrochemistry.

A list of the papers presented and of the discussions held would not be in place here. Many of the European technical journals are giving accounts of the proceedings. The German *Chemiker-Zeitung*, for instance, is publishing valuable abstracts of the papers offered, and reference to its files is advised, pending issue of the complete transactions, promised at the hand of the Secretary-General.

The social features of the meeting were by no means overlooked. An informal evening reception preceded the formal opening of the Congress, previously referred to. A public reception and lunch were given at the *Rathhaus* (City Hall) of the city, by its burgomaster, Dr. Lueger. This gathering was largely attended by the members of the Congress and their ladies.

Several excursions to neighboring places of interest had been arranged; social meetings were held at various places of amusement, and private banquets were held, to which some of our countrymen were bidden a cordial welcome.

The last meeting of the Congress took place August the second, again in the Aula of the University.

Director F. Strohmer, to whose care and efforts the brilliantly successful outcome of the Congress must, in great measure, be credited, took this opportunity to make his report on the work done and the results achieved. He and his able assistants were certainly fully deserving of the gratitude and the appreciation extended to them for their efforts by the grateful members of the Congress.

The next International Congress of Applied Chemistry will take place in Paris two years hence, and Professor Moissan has been charged with the selection of the French Committee of Organization.

It was thought taken of the Grand Exposition to be held in Paris in 1900 that decided the majority of members to cast their vote in favor of Paris in preference to Berlin, although this city also presented strong claims and petitions for the coveted honor of having the coming Congress take place within its walls.

May the day be not far distant when it shall be the pleasure and the good fortune of the United States to welcome to her

shores those men of all nations whose names stand for progress and advance in Applied Chemistry, that branch of our noble science to which America owes no small share of her magnificent development and prosperity.

FERDINAND G. WIECHMANN.

AMERICAN MATHEMATICAL SOCIETY.

THE fifth Summer Meeting of the Society was held at the Institute of Technology, Boston, Mass., on Friday and Saturday, August 19th and 20th. The attendance exceeded that at any previous meeting of the Society, reaching about seventy, including fifty-three members. The number of papers presented also shows a material increase. Nearly all the officers of the Society were present. The President, Professor Simon Newcomb, occupied the chair at the opening session, and was relieved later by the Vice-Presidents, Professors R. S. Woodward and E. H. Moore. The Council announced the election of four new members and the receipt of six applications for membership. A committee of five was appointed by the Council to consider the question of securing improved facilities for the publication of original mathematical papers in this country.

Two years ago a Colloquium was held in connection with the Summer Meeting at Buffalo. At the Toronto meeting last year it was not convenient to retain this feature. But this year it was decided to revive it, and in the week following the regular session twenty-eight members of the Society met at Cambridge to attend the courses of lectures offered by Professors W. F. Osgood and A. G. Webster. The title of Professor Osgood's course was: 'On Some Methods and Problems of the General Theory of Functions;' that of Professor Webster's was: 'The Partial Differential Equations connected with Wave Propagation.' The success attending the Colloquium will probably ensure the retention of this feature at the future summer meetings.

The most cordial relations prevailed between the Society and Section A of the American Association. The latter body set apart a special day (Thursday) for the reading of the chief mathematical papers, an arrangement which was greatly appreciated by those members of the Society who wished to attend both the Colloquium and the meeting of Section A.

The following is a list of the papers presented at the Fifth Summer Meeting:

(1) DR. E. M. BLAKE: 'On the ruled surfaces generated by the plane movements whose centrodes are congruent conics tangent at homologous points.' (Illustrated by models.)

(2) PROF. T. F. HOLGATE: 'A second locus connected with a system of coaxial circles.'

(3) DR. J. I. HUTCHINSON: 'On the Hessian of the cubic curve.'

(4) DR. VIRGIL SNYDER: 'Asymptotic lines on cubic scrolls.'

(5) PROF. ALEXANDER CHESSIN: 'Relative motion considered as disturbed absolute motion.'

(6) PROF. A. L. BAKER: 'Fundamental algebraic operations.'

(7) PROF. ALEXANDER CHESSIN: 'On the development of the perturbative function in terms of the mean anomalies.'

(8) PROF. E. O. LOVETT: 'Note on the differential invariants of a system of $m+1$ points by projective transformation.'

(9) PROF. W. F. OSGOOD: 'Note on the extension of the Poincaré-Goursat proof of a theorem of Weierstrass's.'

(10) PROF. W. F. OSGOOD: 'Supplementary note on a single-valued function with a natural boundary, whose inverse is also single-valued.'

(11) PROF. MAXIME BÔCHER: 'The theorems of oscillation of Sturm and Klein.'

(12) PROF. A. L. BAKER: 'Space concepts in mathematics.'

(13) DR. T. P. HALL: 'An algebra of space.'

(14) PROF. E. H. MOORE, 'The subgroups of the generalized modular group.'

(15) PROF. L. L. CONANT: 'An application of the theory of substitutions.'

(16) DR. J. H. BOYD: 'A method for finding an approximate integral for any differential equation of the second order.'

(17) DR. H. F. STECKER: 'Non-euclidean cubics.

(18) DR. G. A. MILLER: 'On the simple isomorphisms of a Hamiltonian group to itself.'

(19) DR. L. E. DICKSON: 'A new triply-infinite system of simple groups obtained by a twofold generalization of Jordan's first hypoabelian group.'

(20) DR. L. E. DICKSON: 'Construction of a linear homogeneous group in *m* variables.'

(21) MR. JACOB WESTLUND: 'On a class of equations of transformation.'

(22) PROF. F. MORLEY: 'A generalization of Desargues' theorem.'

(23) DR. E. L. STABLER: 'A rule for finding the day of the week corresponding to a given date.'

(24) DR. ARTEMAS MARTIN: 'Evolution by logarithms.'

(25) DR. ARTEMAS MARTIN: 'A method of finding without tables the number corresponding to a given logarithm—II.'

F. N. COLE,
Secretary.

BOSTON MEETING OF THE NATIONAL GEOGRAPHIC SOCIETY.

A SPECIAL meeting of the National Geographic Society was held, in connection with Section E of the American Association for the Advancement of Science, in the lecture hall of the Boston Society of Natural History, August 25th, 2 to 4:30 p. m., Vice-President W J McGee presiding in the absence of President Bell; in addition to the members of the Section, a number of the working members of the Society, including a quorum of the Board of Managers, were in attendance.

The first communication was by Marcus Baker, of the U. S. Geological Survey, on 'The Venezuela-British Guiana Boundary Dispute.' Mr. Baker was the geographer of the Boundary Commission appointed by President Cleveland near the end of 1896, consisting of Justice David J. Brewer, Dr. Andrew D. White, Professor Daniel C. Gilman, Justice Richard H. Alvey and F. R. Coudert, Esquire, with S. Mallet-Prevost as Secretary. This Commission, made up of eminent American citizens, undertook a critical examination of the boundary dispute in that broad and liberal spirit characteristic of American statecraft and diplomacy. Their inquiries were so shaped as to cover the entire history of settlement and occupation of the territory involved; months were spent in searching the archives of both America and Europe for maps and records; and considerable progress was made in the arrangement of this material before the duties of the Commission were brought to an end through an international agreement. While peace-loving citizens and subjects alike rejoiced when the Commission found its occupation gone, those who knew of its work and plans suffered a certain disappointment; for the Commission was the ablest and most disinterested ever created to consider international complications, and the report, if carried out in accordance with the original plan, would undoubtedly have afforded a model for all nations. It was in line with the policy of rendering every line of inquiry exhaustive that the Commission employed a geographer, recommended by the President of the National Geographic Society and the heads of the scientific institutions engaged in geographic work for the federal government. The report of the Commission was far from complete, by reason of the cessation of the work when only well begun, but comprises three octave volumes with a folio atlas, published within a few months. Mr. Baker summarized the geographic material contained in this report, and described the geographic conditions of the disputed territory. His remarks were illustrated by maps compiled from all available sources.

Mr. F. P. Gulliver, of Harvard University, discussed a 'Classification of Coastal Forms,' giving on the blackboard full illustrations of types. The classification proposed is genetic; and the great facility of classifying islands, bars, promontories, sea-cliffs, beaches and other coastal fea-

tures in this way, and thereby forming simple conceptions of otherwise complex phenomena, was happily brought out. The communication marks a noteworthy advance in the coordination of geographic knowledge.

Vice-President McGee gave an address on 'The Growth of the United States,' illustrated by tables and diagrams. It was the purpose of the address to direct the attention of geographers to the more important episodes in the history of the country and the beneficial effect of these episodes on individual and national prosperity. The territorial growth of the United States has been almost unparalleled in the areas acquired, and quite unparalleled in the rapidity and completeness with which the new territory and resources have been assimilated; no acquisition has been followed by disaster or difficulty, while every accession has stimulated enterprise and quickly resulted in increased facilities, augmented population and greatly enhanced individual and collective wealth. The values were shown quantitatively by means of diagrams, which render it clear that the incomparable growth of the United States in enterprise, population, commerce and wealth is directly traceable to that territorial expansion which has been one of the most conspicuous features in the history of the nation. It was pointed out that the Louisiana purchase made America a steamboat nation; that the acquisition of Texas and California made America a railway and telegraph nation, and incidentally that the events of 1898 must bring America to the front in the only line in which she is backward and feeble, *i. e.*, marine shipping. The address is printed in the September number of the *National Geographic Magazine*.

Mr. Mark S. W. Jefferson presented an illustrated paper on 'Atlantic Estuarine Tides.' His data were derived partly from the reports of the U. S. Coast and Geodetic Survey, partly from other sources; they were combined in such manner as to explain the apparent abnormalities in the tides of the middle and northern Atlantic slopes, and to reduce the whole to definite system. The tides of the principal estuaries were tabulated; the bay type and the river type of tide were distinguished; and the relation between configuration and other factors and the ebb and flow of the local tide was illustrated by numerous examples. The paper is one of a series on which the author is engaged, some of which are assigned for early numbers of the *National Geographic Magazine*.

Mr. John Hyde, Statistician of the Department of Agriculture, presented a summary statement of 'Considerations Governing Recent Movements of Population.' Adverting to the marvellous development of transportation facilities within recent decades, the author directed attention to the growing instability of population; to the habit of seeking new lands and climates where conditions of life were more favorable, and to the flocking of people to districts giving promise of material or moral advantage. It is largely to these conditions that the enormous immigration to the United States must be ascribed. It is a significant fact that, when the emigration from fatherlands in Europe to the United States and to the colonies of the home governments is compared, it is found that the greater part of the home-seekers have drifted to America, rather than to the colonies of their own country. This fact indicates that material advantage is but one of the conditions governing movements of population, and that another impressively potent factor is the desire for that intellectual freedom guaranteed to the American immigrant by the Constitution and consistent policy of the United States.

In the absence of the authors, the following papers were read by title: 'Some New

Lines of Work in Government Forestry,' by Gifford Pinchot; 'The Forestry Conditions of Washington State,' by Henry Gannett; 'The Five Civilized Tribes and the Topographic Survey of Indian Territory,' by Charles H. Fitch; 'The Bitter Root Forest Reserve,' by Richard U. Goode.

On motion of Mr. Hyde, the following resolution was adopted:

"WHEREAS, through the increasing consumption of forest products, the destruction of forests and the vast extension of means of transportation, questions hitherto of restricted bearing are rapidly assuming grave international importance, and

"WHEREAS, the National Forest Association of Germany has undertaken to collect throughout the world forest information and statistics of commercial importance.

"*Resolved*, That the National Geographic Society express its deep sense of the value to mankind of the work thus begun, and pledge its countenance and support to the investigation, and

"*Resolved*, That a committee of three be appointed by the Chair to communicate these resolutions to the National Forest Association of Germany, and to take such other steps as may be necessary to carry them into effect."

In conformity with the resolution, the Chair appointed Mr. Gifford Pinchot, of Washington, Chairman, and Messrs. William H. Brewer, of New Haven, and Arnold Hague, of Washington, as a committee to take requisite action on behalf of the National Geographic Society.

W J M

CURRENT NOTES ON ANTHROPOLOGY.

THE CASTINGS FROM BENIN.

WHEN the English captured the city of Benin last year they found and sent to the British Museum some three hundred remarkable bronze castings. These present animal and human figures with various ornaments in relief, the line strong and the workmanship of singular beauty.

The origin of this work has greatly puzzled ethnologists. Carlsen (*Globus*, 1897, No. 20) and Mr. C. H. Read, of the British Museum, think they are the work of some European bronze founders who settled in the sixteenth century. Mr. H. Ling Roth (*Reliquary and Illustrated Archæologist*, July, 1898) attacks this position with some good arguments, but closes his paper with the negative decision that "the question of the origin of this Bini art remains unsolved."

CRANIOLOGICAL INFORMATION DESIRED.

DR. MIES, whose address is 'Schildergasse, 21, Cologne, Germany,' has issued a leaflet requesting particulars as to the greatest breadth of normal adult skulls. Those who can furnish him such information should apply for his leaflet, which is ruled and numbered so that the measurements can be entered in the briefest and most perspicuous manner.

ETHNOGRAPHY OF THE UPPER PARAGUAY.

FOR an American ethnologist it is as agreeable to discover a new linguistic stock as it is for the zoologist to discover a new genus of mammals. This good fortune happened to Mr. Guido Boggiani on the river Paraguay. He obtained a vocabulary from a tribe called Guanas (a Guarani term meaning 'fine people' and applied to various tribes), living near the river about lat. 23° south. It turned out entirely different from any other known tongue. He proposes for it the name 'Ennima stock.' After comparing its words with those of all the stocks anywhere near it, I find no affinities except a few, and these doubtful, with some of the Tsoneca dialects of Patagonia.

The position of the Ennima as well as the other tribes on the upper Paraguay are described and figured by Mr. Boggiani in an article in the *Boletin* of the Argentine Geographical Institute, Vol. XVIII., 1898.

MOTIVES OF SUICIDE.

IN *Globus*, July 16th, Dr. Richard Lasch refers to such motives for suicide as love,

sorrow, fear, melancholy, despair, illness, etc., and adds another—revenge. By numerous quotations he shows that in many primitive peoples, and those partly civilized, a person would kill himself to spite another. This he explains by the belief that the soul of the suicide would have the power to torment his enemy during the latter's life; not only this, but the death of the suicide would be attributed by his kinsfolk to the enemy and the penalty of blood-revenge would be demanded.

Doubtless this is true at times, but the theory is rather too finely spun. Suicide from an obscure motive of this nature is not rare in civilized lands where such beliefs and customs do not exist. Lovers kill themselves that their cold lady-loves may grieve (which they generally do not); children kill themselves that their parents may be sorrowful. Foolish, but human!

D. G. Brinton.

University of Pennsylvania.

NOTES ON INORGANIC CHEMISTRY.

From the twenty-eighth annual report of the Deputy Master and Comptroller of the Mint, 1897, *Nature* has taken a memorandam by Professor Roberts-Austen on the treatment of the surface of medals of silver and bronze. For centuries silver medals have been issued in England with the tables or flat surfaces smooth and mirror-like, while a more or less frosted surface has been given to the portions in relief. Owing to the ready discoloration of the polished surface, in France it has been customary often to use unpolished dies and to give the medals a dead surface by rubbing with pumice. More recently the sand blast has been used for this purpose. This surface may be further treated by immersion in a soluble sulfid, or better in a platinum solution, when a black surface is obtained which may be more or less removed by rubbing with brush and pumice. Very beautiful shadow effects may be obtained, and many medals were thus treated at the (British) Mint in 1897 for the first time.

In the case of bronze metals much of the beauty of the earlier medals was due to the fact that instead of being struck they were cast, and a thin layer of oxid was acquired in the process. Most modern 'bronze' medals are really copper 'bronzed' or artificially colored on the surface. The production of this color is by various methods, but generally by boiling with dilute solutions of certain salts, of which verdigris and sulfate of copper are the most important. The finest work in this line is that of Japanese artists, and its beauty seems to be chiefly due to the quality of the verdigris used. This verdigris, known as 'Rokusho,' is produced by the action of plum-juice vinegar on plates of copper containing certain metallic impurities. Very fair effects in bronzing are obtained with ordinary European verdigris, and this process is used in the British Mint. In France medals are struck of true bronze, with a high percentage of zinc, and the color is improved by gentle heating, producing superficial oxidation, but no true patination.

At the recent meeting of the American Association in Boston a paper was read by Charles L. Reese on quartz crystals from Diamond Post-office, near Guntersville, Marshall county, Ala., which contain inclusions of petroleum. Some of the cavities of these crystals measure as much as 2.3x1.8x1 mm. On warming, the petroleum globule bursts and wets the walls of the cavity. The contents of the cavities were identified as petroleum by the yellow-green fluorescence, the stain of the crushed crystals on filter paper, and the characteristic odor and smoky flame. Petroleum also occurs in the neighborhood where the crystals were found.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

ON the occasion of the meetings of the Congresses of Zoology and Physiology at Cambridge the University conferred its honorary degree of Doctor of Science on Professor H. P. Bowditch, of Harvard University; on Professor Anton Dohrn, Director of the Zoological Station at Naples; on Professor Alphonse Milne-Edwards, Director of the Museum of Natural History at Paris; on Professor Camillo Golgi, professor of general pathology in the University of Pavia; on Dr. Ernst Haeckel, professor of zoology in the University of Jena; on Dr. A. A. W. Hubrecht, professor of zoology in the University of Utrecht; on Dr. Hugo Kronecker, professor of physiology in the University of Berne; on Dr. Willy Kühne, professor of physiology in the University at Heidelberg, and on Professor E. J. Marey, professor of natural history at the Collège de France.

GENERAL SÉBERT has been elected Vice-President of the French Association for the Advancement of Science and, in accordance with the custom of the Association, will be President at the Paris meeting of 1900. M. Brouardel will preside at the meeting next year, which will be held at Boulogne.

DR. W. McM. WOODWORTH has been appointed assistant in charge of the Museum of Comparative Zoology, of Harvard University.

PROFESSOR ROBERT HELMERT, Director of the Geodetic Institute at Potsdam, has been elected a corresponding member of the Göttingen Academy of Sciences.

DR. H. KIEPERT, professor of geography at Berlin, has celebrated his eightieth birthday.

DR. K. GOEBEL, professor of botany at Munich, has gone to Australia for purposes of botanical research.

PROFESSOR ADOLF BASTIAN, of Berlin, has returned from his expedition to southeastern Asia, where, during the last two and a-half years, he has been carrying on important ethnological investigations.

DR. W. F. HUME will, during the coming year, make surveys in the peninsula of Sinai, under the auspices of the Egyptian Geological Survey.

DR. L. A. BAUER, of the University of Cincinnati, was made an honorary member of the Société Scientifique 'Antonio Alzate,' Mexico, at its meeting of July 5, 1898.

M. PILLIET has been appointed Director of the Musée Dupuytren, which contains the anatomical collections of the medical faculty at Paris.

A MONUMENT to Gui Patin, in the middle of the seventeenth century professor of surgery and Dean of the Paris faculty of medicine, was unveiled at d' Hodenc-en-Bray, his native place, on August 22d.

WE regret to record the death of Dr. Paul Glan, associate professor of physics in the University at Berlin, at the age of fifty-two years; of Dr. E. J. Bonsdorf, formerly professor of anatomy and physiology in the University of Helsingfors, at the age of eighty-eight years; and of Professor L. von Dittel, formerly professor of surgery at the University of Vienna, at the age of eighty-three years.

THE Nineteenth Congress of French Geographical Societies will meet at Marseilles from the 18th to the 25th of September.

WE learn from *Nature* that a Congress of the Astronomische Gesellschaft will be opened at the Academy of Sciences at Budapest on September 24th. Meetings will also be held on Monday and Tuesday, September 26th and 27th. The Hungarian members of the Society have prepared a cordial reception for the astronomers who attend the Congress, among the hospitable features being a luncheon to be given by the Minister of Public Instruction (Dr. Julius von Wlassitz), a dinner by the town of Budapest, visits to places of interest in the town and neighborhood and excursions to the O'Gyalla Observatory and the Danube Cataracts—the Iron Doors. The Congress will certainly give a prominent place to the discussion of questions concerning the international zone catalogue of the Astronomische Gesellschaft; and the resolutions of the Paris Conference, which have given rise to a large amount of criticism, will also be dealt with. Professor F. Porro will present a preliminary report on the revision of the Piazzi Catalogue of Stars, undertaken by Dr. H. S. Davis and himself.

THE Venice Academy of Science, Letters and Arts offers a prize of $600 from the Querini-Stampalia Foundation, for an investigation of the water power of the Venetian province, with a view to its increased application. Essays, which may be written in English, must be presented before the end of next year.

THE Dutch Academy of Sciences of Harlem proposes eighteen subjects for essays, offering for each a gold medal or a prize of 500 florins. The details may be obtained from the Secretary of the Academy, Professor J. Bosscha, Harlem.

MME. BRAGAYRACT has bequeathed 50,000 fr. to the Paris Academy of Medicine.

PLANS are being made at Turin for the establishment of a fresh-water aquarium intended to advance the interests of pisiculture.

THE Indian government has decided to send exhibits from the Forest and Geological Department to the Paris Exhibition at a cost of about £3,000.

THERE are now about 350 public libraries in Great Britain. These libraries contain over 5,000,000 volumes, and issue about 27,000,000 books each year. The annual attendance of readers is about 60,000,000. In comparison with these figures the following, recently published, will be interesting: There are 844 public libraries in Australia, with 1,400,000 volumes; 298, with 330,000 volumes, in New Zealand; 100, with 300,000 volumes, in South Africa. In Canada the public libraries contain over 1,500,000 volumes. In 1896 the United States, according to government statistics, possessed 4,026 public and school libraries, containing 33,051,872 volumes.

Nature states that a committee, having upon it many distinguished men of science in Australia, has been formed to secure the establishment of some permanent memorial to commemorate the services rendered by the late Baron von Mueller. This movement is entirely distinct from that which the executors of the late Baron have initiated with the object of obtaining funds for the erection of a tombstone. The object of the Committee of the National Memorial Fund is to secure sufficient funds to allow of the establishment of some permanent memorial which shall worthily perpetuate Baron von Mueller's name; and whilst it is not possible as yet to state definitely the form which the memorial will take, it is hoped that sufficient funds will be forthcoming to provide for (1) the erection of some form of statue, and (2) the endowment of a medal, prize or scholarship, to be associated with Baron von Mueller's name, and to be awarded from time to time in recognition of distinguished work in the special branches in which he was most deeply interested, and which shall be open to workers throughout the Australasian colonies. Subscriptions to the fund may be sent to the Hon. Treasurer, addressed to the College of Pharmacy, Swanston Street, Melbourne, or to the Hon. Secretaries (Mr. W. Wiesbaden and Professor Baldwin Spencer), addressed to the University of Melbourne, and will be duly acknowledged.

CHANCELLOR HOHENLOHE has sent a communication to the German Colonial Society in reply to a request for information as to the official attitude towards Professor Koch's theories on the subject of malaria. He says, as reported in the New York *Evening Post*, that as soon as the Colonial Department of the Foreign Office "had knowledge of the highly important results of the investigations of Dr. Koch, and of the proposals based on them by him, it distributed the information in several directions. Dr. Koch appealed, for instance, to the Prussian Ministry of Medical Affairs, to which he is officially subordinate, that means should be obtained for two great scientific expeditions under his leadership, with a view to completing his investigation of malaria. According to his plan, the first of these expeditions should investigate malaria in Italy and Greece, and the second in the most intense fever foci of East Africa, India and New Guinea. The first is to last three months and the second two years. The Prussian Ministry and the Foreign Office are most keenly interested in this enterprise, and I do not doubt its practicability. * * * In order to render the present results of Dr. Koch's researches concerning the diagnosis treatment and prophylaxis of malaria useful to medical men in the colonial service, suitable training will be given them in the Institute for Infectious Diseases, of which he is the head. This train-

ing is given under Dr. Koch's superintendence, and several medical men are already receiving it. The colonial doctors will also be provided with the scientific apparatus proposed by Dr. Koch. Each of them will thus be enabled to turn the special scientific training received by him for his work in our protectorates to account, furnished with all the means of modern science in exact accordance with Dr. Koch's prescriptions and doctrines."

THE German Arctic expedition of Theodore Lerner, which started in May last to search for Andrée and to carry on scientific investigation, has returned to Hammerfest, Norway, in order to enable the *Helgoland*, to refit prior to starting on another voyage. Herr Lerner could find no trace of Andrée, but secured scientific results of interest especially to geographers. A special representative of the *Berliner Lokalanzeiger*, who accompanied the expedition, has forwarded to that journal a long and detailed account of the voyage, of which an abstract is given in the London *Times*. Horn Sound was reached after some difficulty; owing to the unusual quantity of floe ice, which, breaking off from the glaciers, kept sweeping down with terrific force, anchorage was rendered very difficult and dangerous. Towards the end of July King Charles Islands were reached, where a halt of a few days was made. From scientific observations made they were able to define the exact position of the islands, and they discovered that the English and Norwegian maps were slightly inaccurate. The group consists of three big islands—namely, Swedish Foreland, Jena Island, and a third lying between these two, which they christened August Scherl Island in honor of the promoter of the expedition. There they came upon the breeding grounds of the ivory gull (*larus eburneus*), very few specimens of whose eggs have hitherto been discovered. Two small islands in the southern bay of Jena Island received the names of Tirpitz and Helgoland respectively. Captain Rüdiger took special observations of the exact position of King Charles Islands. An attempt to push on to Franz Josef Land failed owing to bad weather. The *Helgoland* then was able to coast round the island on the northeast and from the south, in spite of the difficulties caused by fog and ice, thereby proving that it is possible to go northwards notwithstanding the contrary Polar currents. The exact position of the island of Störö is given as being 10′ farther north than it is at present indicated on maps. The most northerly point reached was latitude 81° 32′, where the boundary of pack ice was determined. Much hitherto unknown ground was fished with dragnets, especially round the east point of King Charles Islands, and at the extreme end of Spitzbergen in waters of over 1,000 meters deep. A good deal of interesting material was found. No signs of the Andrée expedition were discovered. Many seals and a large number of reindeer were killed, as well as forty-four exceedingly fine polar bears. Four live cubs are being brought back to Germany. Professor Richard Friese, the celebrated animal painter, was able to make some excellent sketches, and many photographs were taken of the hitherto unexplored lands. Among other interesting subjects for future investigation by bacteriologists it is stated that the existence of plankton was established at over 100 hauls of the dragnets. The expedition will start on another voyage of exploration as soon as the ship has been refitted and the necessary stock of victuals been taken on board.

THE program of the forthcoming meeting in Sweden of the Iron and Steel Institute, says the London *Times*, opens up a prospect of an unusually important gathering, not so much from the point of view of the papers to be read —although they are of great interest—as from that of the information which the members of the trade are likely to obtain as to the suitability of the iron-ore resources of that country to their urgent requirements in the near future. The papers include one on the most prominent and characteristic features of Swedish iron-ore mining, by Professor Nordenström, and another on the iron-ore deposits of Swedish Lapland, by Mr. Lundbohm, of the Swedish Geological Survey. These papers, and the discussions on them, will be supplemented by a special excursion to the mines within the Arctic Circle. The ore in that region is of the highest quality—much higher in iron than any other similar deposits in Europe—and it is believed that, when a new railway has been completed to connect

the mines with the Atlantic Ocean, the ore can be delivered in England as cheaply as any supplies now available on a large scale. Another important subject to be discussed is the action of explosives on the tubes of steel guns, as to which Professor Roberts-Austen, C.B., of the Mint, will read a paper based on important recent experiments, while the proper composition of steel rails, which will also be debated, will be of unusual importance, in view of the inquiry by the departmental committee of the Board of Trade. Several other papers of a more highly technical character will be considered, while the hospitality to be offered to the visitors will include a reception by King Oscar at his summer palace, and a banquet by the Association of Swedish Ironmasters. Dr. H. S. Lunn has specially fitted up the steam yacht *Argonaut* to convey the members to Sweden, and she will serve as a floating hotel during their stay.

IN introducing an article on 'The Species, the Sex and the Individual,' by Mr. J. T. Cunningham, the editor of *Natural Science* makes the following remarks: "With reference to this paper Mr. Cunningham has given us the following information, which we have verified. The paper was written at the beginning of 1897, and after some time was submitted to the Zoological Society, but not accepted, even for reading, on the ground that the Society did not usually publish papers of a theoretical and controversial character. The manuscript was then sent to the Linnæan Society, where it was read on May 6th of the present year, and a brief description of it was published in the report of the meeting in the *Athenæum* and in *Nature*. But this Society also refused to publish the complete paper, the alleged reason being the pressure of other papers and illustrations. It is due to Mr. Cunningham that these facts should be known, for on June 7, 1898, there was read before the Zoological Society a paper by Mr. L. W. Wiglesworth, containing conclusions as to sexual dimorphism very similar to those of the present paper. In particular, as published abstracts show, the author maintained that secondary sexual characters in birds were due to the stimulation of parts through use, or external violence, or irritation. So much for Mr. Cunningham's title to priority. As for the refusal to publish his paper we understand that the Zoological Society has equally refused that favor to Mr. Wiglesworth, although he was more fortunate in having his views placed before a meeting and published in abstract. There is a general feeling among those who hold views opposed to the current strictly Darwinian notions that they cannot get fair play from our learned societies. It is a pity that they should be able to adduce so many facts in support of this opinion, however erroneous the opinion itself may be."

UNIVERSITY AND EDUCATIONAL NEWS.

THE corporation of Brown University has accepted the resignation of Dr. E. Benjamin Andrews as President, passing resolutions expressing appreciation of his services, and has elected a committee of six to choose his successor. Professor Benjamin F. Clark, A.M., has been made Acting President.

DR. W. WALDEYER, professor of anatomy, has been appointed Rector of the University of Berlin, for the coming year; Dr. von Lonmel, professor of physics, Rector at Munich, and Professor Luigi Luciani, the physiologist, Rector of the University of Rome.

THE vacancies in the fellowships of the Teachers College caused by the resignation of Dr. Cleveland Abbe, Jr., and Mr. E. B. Bryan, have been filled by the appointment of David R. Major, Ph. D. (Cornell), and B. B. Breeze, A. M. (Harvard). Mr. Breeze has been for the past two years assistant in the Harvard Psychological Laboratoy.

MISS KATHERINE VON TUSSCHENBROCK has been appointed to a chair of gynæcology in the University of Utrecht. The University of Genoa has given its M.D. to Miss E. Bonomi, which is said to be the first time the degree has been given to a woman by an Italian University.

DR. GEORG KLEBS, professor of botany at Bâsle, has been called to Halle and is succeeded at Bâsle by Dr. Wilhelm Schimper, associate professor at Bonn.

THE position of instructor in histology at the Harvard Medical School is vacant. The appointment is an annual one with a salary of

four hundred dollars. The holder is expected to give twenty hours a week to the work of the laboratory, and to devote the remainder of the time to original investigation in histology or embryology under the supervision of the senior officers of the department. Applications should be addressed at once to Professor Charles S. Minot, Harvard Medical School, Boston.

DISCUSSION AND CORRESPONDENCE.

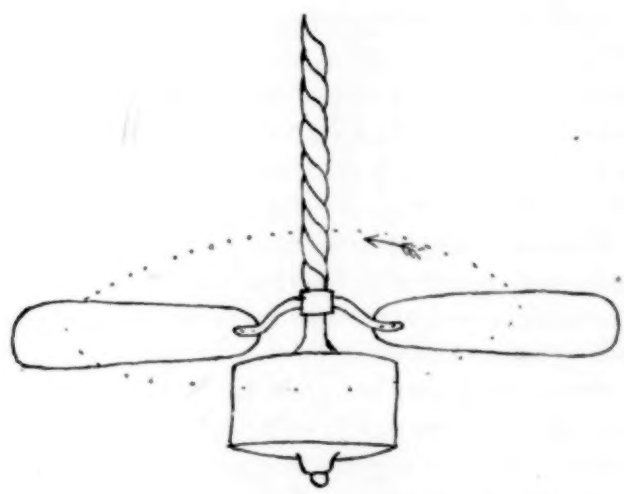
PRE-COLUMBIAN MUSIC AGAIN.

TO THE EDITOR OF SCIENCE: The question of pre-Columbian stringed instruments of music in America comes up again, this time from Carl Sapper, the distinguished geologist in Coban, Guatemala. He had learned of my former letter on the distribution of the musical bow and concedes with regard to the Loltun Hool, of the Mayas, that it was surely introduced from Africa, since the Kekchi call it marimbadie, or caramba. The same instrument is in use among the Xicaques, in Honduras, but they attach a guacal as a resonator. Dr. Sapper does not agree with me that the stringed musical instrument was entirely absent from the western hemisphere, for, says he, the Lacandones have a two-armed guitar, which he thinks not to have been borrowed. The Kekchi also, says Sapper, uses strings on the scraping instrument, called 'su.' This is entirely new to me. As to the double-necked guitar, Mr. E. H. Hawley says that they were common in Europe and may be seen in collections. These have the necks projecting from the same end and parallel or slightly diverging. The Fans have a variety in which the two necks start from opposite sides of the body. One example is made from the stem of a palm leaf 55 inches long. Four strings are cut from the outer skin, their ends being left attached. A little way from the middle a stick is set up perpendicular to the palm stem. On one margin of this are cut four notches or steps, about half an inch apart, to receive the strings. Braided bands of palm fibre encircle stem and strings, and by moving these the latter are tuned. Opposite the upright stick or bridge is tied an open gourd for resonator. I should be glad to receive descriptions of these Central American instruments or drawings. Most of all, would I like to examine specimens. If by the scraped instruments Dr. Sapper means some modification of the notched fiddle, then he has found a prize, but not necessarily a pre-Columbian one.

O. T. MASON.

A CURIOUS OPTICAL ILLUSION CONNECTED WITH AN ELECTRIC FAN.

A CURIOUS illusion connected with an ordinary two-winged pendant fan, such as are commonly employed in restaurants, barber shops, etc., attracted my attention some years ago, and lately, upon my return to the same place, was just as evident as formerly. Very much at a loss for an explanation, the phenomenon was described to one of our leading psychologists and educators, but no satisfactory explanation was obtained. Hence, it is supposed that possibly the phenomenon has not been noticed by others, and is described here for the benefit of those concerned and with the hope of drawing out similar observations by others.



The illusion consists in the fan appearing to rotate in the opposite direction from the real one. Sitting some thirty feet away and looking at the fan, which is moving at a moderate speed, it is plainly seen to be moving in the direction opposite to that of the hands of a watch. The plane of rotation appears to be horizontal. But as one continues looking the vanes suddenly seem to move in the opposite direction and the plane of rotation to change so as to incline towards the observer. The change is under the control of the will and may

be produced as readily as the illusions connected with a square within a square. A certain distance for a point of observation and also a certain speed of rotation appears to be necessary, for fans nearer the observer rotating more slowly do not produce the phenomenon which now seems to be due to the same principle of accommodation that makes a figure of a square within a square appear at one time as a hollow space and at another as a solid.

Two other illusions connected with the fan, but which may be well known to every one who has watched moving machinery, may be noted. In one the vanes, instead of rotating, seem to flap together; in the other the two iron arms appear to be continually withdrawing into and pushing out from the hanging rod.

F. C. Kenyon.

SCIENTIFIC LITERATURE.

Plant Life, Considered with Reference to Form and Function. By Charles Reid Barnes, Professor of Plant Physiology in the University of Chicago. New York, Henry Holt & Co. 1898. 12mo. Pp. x + 428.

In his preface the author says: "The absence of an elementary account of the form and functions of the plants of all groups has made itself felt," and "I am not aware that any book at present attempts to meet this need." These sentences, coupled with the author's reference to secondary schools, and to pupils of thirteen to eighteen years of age, indicate the purpose and place of the book.

In carrying out his plan he has divided the subject into four parts, viz.: (1) the vegetative body; (2) physiology; (3) reproduction, and (4) ecology. In the first part appear such chapter headings as 'the unit of structure,' 'single-celled plants and colonies,' 'linear and superficial aggregates,' 'the thallus of the higher algæ,' the fungus, body of hyphal elements,' 'liverworts and mosses,' 'fernworts and seed-plants.' A few years ago such an approach to what was then called 'morphology' would have horrified the old-time teachers of elementary botany, who were anxious to give the study as much 'practical' value as possible, and were wont to repeat pedagogical platitudes as to the necessity of 'proceeding from the known to the unknown.' Ignoring such objections, the author leads the pupil, chapter by chapter, from the relatively simple plant-body of the fission algæ to the highly complex structures, roots, stems and leaves, of the seed plants. The significance of the latter is thus made much clearer than by the old method of studying the anatomy of flowering plants first, and then following with something of the lower forms from which they sprang.

The treatment of the physiology of plants is satisfactory, as a matter of course, since the author has given especial attention to this department of botany. In the introduction some clear and useful definitions are given; then follows a suggestive chapter on the maintenance of bodily form, one on nutrition (particularly well done), one on growth and another on the movements of plants.

The chapters relating to reproduction must be very helpful in giving the beginner right notions as to how plants provide for a succession of individuals. Old-fashioned people will open their eyes when they find the 'flower' discussed in the chapter treating of vegetative (*i. e.*, asexual) reproduction, along with 'fission,' 'budding,' 'spores' and 'brood buds.' The 'flower' is brought in under the general topic 'spores,' after the discussion has led up to the differentiation of spores into megaspores and microspores. Of course, this is all right, as every botanist knows, but there will be some scrambling and tumbling on the part of many a high-school teacher as he attempts to lead his pupils through this, to him very new, territory, and we imagine that he will fare little better when he comes to the angiosperms in the chapter on sexual reproduction. In order fully to master this matter the teacher will, in most cases, be obliged to spend a term or two in some good botanical laboratory, where he can be helped over the difficult places.

The chapters on ecology are new to American books on botany, and while they are quite elementary they will be useful in the way of directing students and teachers into a comparatively new field of work.

The appendices are in some respects of more value than the body of the book, giving as they do: (1) directions for laboratory study; (2) direc-

tions for collecting and preserving material; (3) lists of apparatus and reagents; (4) lists of reference books, and (5) outline of classification.

Some new uses of old terms are introduced here and there. Thus we have 'ovary' used for oogone, carpogone and archegone, and 'ovulary' for the structure hitherto called the ovary in the flowering plants. 'Sperm' and 'spermary' replace antherozoid and antherid. 'Egg' is consistently used throughout for the female gamete. We do not quite like the use of 'megaspore' as synonymous with 'embryo sac' in angiosperms, and feel sure that it will lead to the confusion of the beginner. It is doubtless impossible to make a clear statement of all the homologies of the gametophyte of angiosperms in an elementary work, but it is certainly not necessary to simplify the statement by running together two structures so distinct as the uninucleate megaspore and the multinucleate embryo sac.

We trust that the author's wish may be realized, namely, "it is greatly to be desired that the too common thought of plants as *things to be classified* may be replaced by the conception of them as *beings at work, to be studied alive*," and we believe that his book will help to bring it to pass.

CHARLES E. BESSEY.

Grundprobleme der Naturwissenschaft. Briefe eines unmodernen Naturforschers. By DR. ADOLF WAGNER. Berlin, Gebrueder Borntraeger. 1897. Pp. vi + 255.

The sub-title of this sharp little polemic might well have been *Schopenhauer versus Büchner.* There is much else in the book, but that about it which is most vital is the application of the philosophy of *Welt als Wille und Vorstellung* to such views of nature as characterize *Kraft und Stoff.* But the actual sub-title does very well. 'Unmodern' the author certainly is. *Kraft und Stoff*, his arch-enemy, long ago had its day; and even the aftermath of discussion over Ostwald's Lübeck address, the most modern scientific matter of which he seems conscious, has been garnered in. This is the most obvious fact about the book; it is belated. The ultra materialistic views of nature and the hard and fast notions of matter, atom, molecule, ether, etc., which the author ascribes to naturalists, are no longer held by them, or are held with a genial flexibility which make the Doctor's savage onslaught seem whimsical.

Then, the book is arrogant in tone. Rarely in these days does the venerable speculative philosophy so lord it over youthful science. Although the book takes the form of letters (in reality a single letter) addressed by a humanist to an old university friend in the other camp, yet the 'lieber Freund,' in spite of the constant 'Du' and 'Dir,' everywhere gets hard blows and short shrift. His views are 'nonsense,' 'absurd,' 'impossible to one who has had a single semester of philosophy,' etc.

And yet it would not be easy to find a better *résumé* of the idealist position with regard to the fundamental problems of nature and science. The book is very readable. It is full of matter. The style is picturesque, lively and popular; the argument clear and mercifully brief. It is a strong book of its kind.

The first half of the book is a coherent argument for a certain view of the world; the second part seems to be occupied (I have not read it completely) with an elaborate *a priori* discussion of the nature of human, animal and plant life. With regard to this part it is only necessary to remark how the philosopher, after belaboring the eternal *is* (the assumption of existence and reality) of science, allows his own equally gratuitous *must be* to run riot. How should it be so difficult to see that we cannot any more get outside and beyond ourselves in philosophy than in science. We project ourselves into our science. Granted. But so, too, we project ourselves into our philosophy, which is, out and out, as truly as science, a creature of taste, mood, temperament, race, age and environment.

What, then, are the 'Grundprobleme?' They are questions concerning the nature of things; concerning criteria of reality; concerning the relation of experience to knowledge. You scientists build upon experience. First find how far experience is valid. You talk of realities. What do you mean by reality? What are your tests of reality?

The author, though everywhere affirming the idealist position, very sensibly refrains from any

close classification of his philosophy. In general he might be spoken of as a spiritualistic monist, since he finds nothing in the world but the human will and the human will anthropomorphically projected into space, which projection he follows Schopenhauer in calling force (Kraft), and its localized manifestations energy. But this lightly held monism easily lapses into pluralism, and when he gets all his contestants on the arena together a pretty contest they put up. For example, first appears *reality as it is in itself*—a ghostly presence. To him enters the burly and self-confident *common notion of reality*, easily holding all eyes upon himself. Then comes in that keen-witted fellow, *interpretation of reality*, striving to put *notion of reality* in a hole and get on good terms with *reality itself*. And this is only a beginning. Even space and time appear to be distinct entities. For, speaking of the production of like effects by like causes, he says very truly that there are no two like causes. At least they must differ in place and time; which is very interesting if one thinks of it.

Then is the author wise in insisting, to the extent we find in the earlier chapters, upon the opposition of experimental science to speculative philosophy? He first gives standing to speculative philosophy by showing how all thinking, even scientific, is speculative, and then adroitly attributes to speculation its old meaning of inquiry into causes, essences and realities. Science is now the servant of speculation, or, to use his favorite figure, the hod-carrier bringing bricks and mortar to the philosopher-architect. But how if the hod-carrier chooses to be his own architect, finding that the man of speculation does not feel the properties of the material which he has not encountered at first hand, and that so his construction is not sound. And when reminded that the bricks and mortar of experience are man-made, can he not retort; but so is the temple? And may not this suggestion of inferiority sting him into asking whether any one of this endless succession of temples, falling into ruin almost as soon as built, is really a more noble object than the almost eternal elements of which each one in turn is made?

And is not the Doctor wrong in insisting that men of science decry speculative philosophy? They only object to that which is not sober and fruitful. Speculation, indeed! They all love it as the apple of the eye! Who does not know that they live on bread and water and wear the hair shirt of inexorable verification to moderate this tendency. Dr. Wagner is right in thinking that all people have a deep interest in the nature of things, in cause, and necessity, and reality. Who among us is so much a positivist as to say, not only that we have not yet penetrated the soul of things, but that we never can; that it would be of no use if we could; that we ought not even to desire to. The experimental philosopher (if Dr. Wagner will permit this hated expression this once) does not travel the noble road of speculative philosophy simply because he has found that *for him* it is hedged up or leads no-whither. What does Dr. Wagner himself bring back from his search? Has he found an answer to his questions? Who has accepted this answer? While experimental science has been building up a body of knowledge which it is a liberal education to know, what sure and well accredited doctrine has speculation to offer? Where does it impinge upon science? How help, or illuminate, or direct? This is no objection to philosophy, but to its arrogance.

The chapters upon causality, or rather the law of causality, are suggestive, though not new. If there is some juggling with words here, where is there not in any full discussion of the subject? Every event is both cause and effect; the emphasis upon every. So the universe is all of a piece; all events in one series. This implies necessity and excludes accident. But cause in itself is one thing, cause for us another. Two events may belong to two, or many, quite different (for us) causal series. The motion of necessity does not exclude the motion of accident. Still there is no absolute accident. Causality has reference to becoming—development—and not to existence; *e.g.*, to heating, and not to heat; to vital changes, and not to life. He properly objects to divorcing form from content. If one rubs a glass rod with fur one does not bring about two results—create electricity and electrify the rod—but only one, the latter.

He follows Liebmann, *Analysis of Reality*, in asserting that force is not true cause. For example, force cannot produce motion. But he has in mind Schopenhauer's idea of force, a sort of synthesis of the powers of nature—may one say, the total potential energy of the universe—the thing-in-itself of the metaphysician. True force—always something akin to the human will—is that which releases this fundamental power, producing the various manifestations of energy. The true cause of the falling of a stone, for example, is not gravity, but the removal of an obstacle; and so in all motion. This view, sufficiently common in one form or another, may have little significance for physics, which concerns itself with the how and how much rather than the what and why, but is intrinsically important and deserves greater elaboration than it has hitherto received.

This view leaves no place for matter as something upon which force can act or in which it may 'reside.' The universe is to be explained dynamically. So all talk of atoms and molecules, except as for a time they may pictorially assist the learner, is aside from the purpose. They may be handy to have about, as they make no trouble and deny nothing, but they also explain nothing. Ostwald's concept is the true one, simply putting will for force and acts of will for energy.

For it is the world of will—of longing, of striving, of action—of which we are conscious. Here is the real world. But the will encounters opposition from without on the part of something which we feel to be akin to the human will—the powers of the external world. The nature of the world is will.

E. A. STRONG.

YPSILANTI, MICH.

International Catalogue of Scientific Literature. Report of the Committee of the Royal Society of London, with Schedules of Classification. March, 1898. Schedule Q, Anthropology.

It will be remembered that at the International Conference for a Catalogue of Scientific Literature, held at London, July, 1896, the classification of the sciences to be catalogued was referred to the Committee of the Royal Society for organization. The report of this Committee is now published, and it is to its classification of the Science of Anthropology (known as 'Schedule Q') that the present review is confined.

The Committee states that these schedules 'are not put forward as final or authoritative' (p. 9); therefore, an examination of them should be carefully carried out by special workers in science, to see how far a catalogue based upon them will reach the highest degree of usefulness.

Obviously, the schedule should include all the prominent branches of a science, and should reduce repetition of titles to a minimum.

With regard to Anthropology the Committee excludes from it the branches of experimental and comparative psychology, grouping these under the general schedule of 'Psychology' (Schedule P). While the anthropologist may regret this, it is in accordance with the precedents of the American Association and other similar bodies.

The general science of anthropology is divided into eleven primary branches, as follows: (1) Museums and Collections; (2) Archæology (prehistoric); (3) Anthropometry; (4) Races; (5) Industrial Occupations and Appliances; (6) Arts of Pleasure; (7) Communication of Ideas; (8) Science ('chiefly of primitive races'); (9) Superstition, Religion, Customs; (10) Administration; (11) Sociology ('chiefly of primitive races'). The total number of sub-headings is seventy.

What will first impress the anthropological student in this classification of the subjects of his science are its omissions. Nothing is said of that most prominent branch sometimes called 'developmental somatology,' which investigates the influences of heredity and environment and the physical transformations of man (evolution, monogenism, polygenism, etc.)

The whole science of ethnography, as such, is overlooked, as under the unfortunate heading 'races' the only sub-titles are 'General Works,' 'Classification by Name and Language,' 'Racial Peculiarities.' Another ill-chosen term is 'arts of pleasure' as a synonym for the fine, or æsthetic arts. Many of the most noteworthy developments of these are in no sense ministers to

pleasure, such as the vast domain of religious and symbolic art; and consequently under none of the sub-headings are these mentioned. Why 'administration' and 'sociology' should be separated is not obvious, and that it is erroneous is apparent from the substantial duplication of the sub-headings, as 'marriage' under the former, 'relations of the sexes' under the latter; 'crimes' under one, 'ethics' under the other; 'governing powers' under the one, 'family and clan' under the other, and so on.

A curious omission in these days is that of folk-lore from the leading titles. It is a clear-cut, independent branch of anthropology, with a field of its own and a vast literature; yet it appears only as a third-rate subordinate subject; though the Committee perhaps thought to make amends for this by inserting it twice, once under 'arts of pleasure' and again under 'superstitions!' This would involve duplicating at least a thousand titles a year. The drama is placed under 'arts of pleasure,' history under 'science,' while writing and records are included under 'communication of ideas.' This seems a forcible divulsion.

The advanced anthropology of the present day does not intend to confine itself to 'primitive races' nor prehistoric remains, but aims to study the progressive and regressive developments of the species Man as a whole, and as divided by natural or artificial lines into groups, ethnic or demotic. All art, science and history, when treated in this spirit and for this purpose, become the material of the anthropologist, and the subjects of his investigation.

This broad comprehension of the spirit of the science seems obscurely set forth, or rather, is not at all recognized in the items of the schedule, and it is earnestly to be hoped that before it is proceeded with, it will be recast in a frame more adequately adapted to represent the true scope of anthropology.

D. G. BRINTON.

SCIENTIFIC JOURNALS.

THE greater part of the *Botanical Gazette* for August is taken up by an extensive and elaborately illustrated article carried out under the direction of Professor Geo. F. Atkinson, on the 'Development of some Anthracnoses,' by Miss Bertha Stoneman. The paper aims to ascertain, by the growth-characters developed in artificial cultures, the relationships of certain fungus diseases grouped under the common name of anthracnoses and the connection of these imperfect fungi with perfect stages. The other article of the number, by Mr. William L. Bray, discusses the relation of the flora of the lower Sonoran zone in North America to the flora of the arid zones of Chili and Argentine.

THE *American Naturalist* for August contains the following articles: 'Dentition of Devonian Ptyctodontidæ,' C. R. Eastman; 'The Wings of Insects' (III), J. H. Comstock and J. G. Needham; 'Alternation of Sex in a Brood of Young Sparrow Hawks,' R. W. Shufeldt; 'Noxious or Beneficial? False Premises in Economic Zoology,' Samuel N. Rhoads; and 'A Pocket Mouse in Confinement,' J. A. Allen.

THE frontispiece of *Appleton's Popular Science Monthly* for September is a portrait of Charles Goodyear and a sketch of the life of the inventor of vulcanized rubber is given by Mr. Clarke Dooley. The opening article is an illustrated account of geological waterways across Central America, by Dr. J. W. Spencer. There are popular entomological papers by Clarence M. Weed and Margaret T. D. Badenock, and several articles on educational and sociological topics.

NEW BOOKS.

Introduction to the Theory of Analytic Functions. J. HARKNESS and F. MORLEY. London and New York, The Macmillan Company. 1898. Pp. xv + 336. $3.00.

Inorganic Chemistry According to the Periodic Law. F. P. VENABLE and JAMES LEWIS HOWE. Easton, Pa., The Chemical Publishing Company. 1898. Pp. v + 266. $1.50.

Organic Evolution Considered. ALFRED FAIRHURST. St. Louis, Christian Publishing Co. 1897. Pp. 386.

The Psychical Correlation of Religious Emotion and Sexual Desire. JAMES WEIR, JR. Louisville, Ky. 1898. Pp. 338.

The Elements of Physics. ALFRED PAYSON GAGE. Boston, Ginn & Co. 1898. Pp. viii + 381.